· DECEMBER 1951 ·

Departments

TOO PURE TO DRINK

Purity of 99.999%, even in water, costs many times as much as vintage champagnes, when obtained in experimental volumes and by laboratory methods. Yet, aided by extensive B&W research, many large boilers are now able to produce steam with as high a degree of purity—at a rate of 16 million tumblersful and more, every hour.

Guaranteed purity of one part solids per million parts of steam is now standard practice with the B&W Cyclone Separator illustrated above. This is sufficient to control turbine maintenance within high-availability limits.

Can it be improved? Yes, though undoubtedly removal of the last small fraction of undesirable impurity will be the hardest nurdle yet in the race of continuing research on this problem.

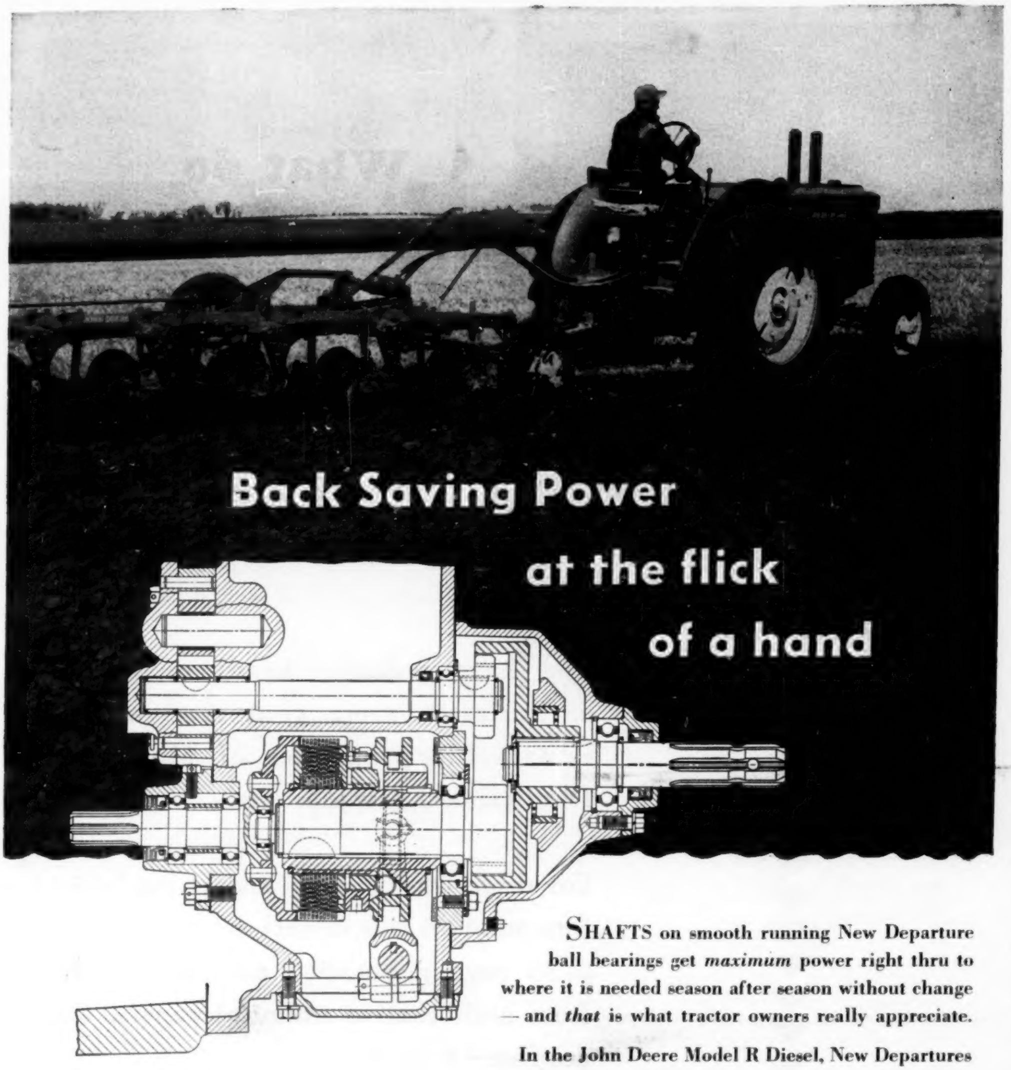
Progress is being made in determining the matter and form of impurities carry-over, with a view to its further reduction both by chemical treatment and mechanical separation. Laboratory samples having as little as 1/100 part impurity per million of water—so pure they must be kept in plastic bottles to prevent migration of silica from glass containers — are now undergoing intensive study by B&W.

This kind of creative research characterizes B&W's broader conception of service. Today, in lab and shop and field, it is discovering the answers to tomorrow's problems in fuel-burning and steam generation.

Helping Industry Cut Steam Costs Since 1882—through Research, Engineering, Equipment, Erection and Maintenance Services.

BABCOCK & WILCOX

N-121



Direct engine-driven Power Take-off and Hydraulic "Powr-Trol" pump for operation of attachments to the John Deere Model R Diesel Tractor are engaged or disengaged at will by an independent clutch.

SHAFTS on smooth running New Departure ball bearings get *maximum* power right thru to where it is needed season after season without change — and *that* is what tractor owners really appreciate.

In the John Deere Model R Diesel, New Departures on the independent clutch, power take-off and hydraulic pump shafts assure back saving power at the flick of a hand for raising, lowering, angling or driving of attachments.

New Departure, Division of General Motors Corp., Bristol, Connecticut.

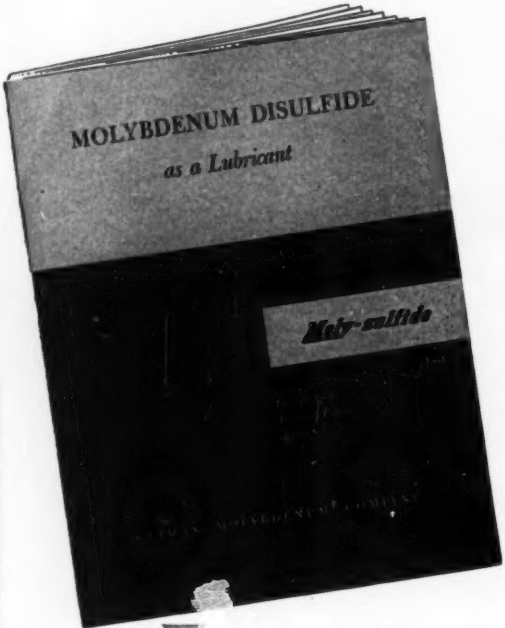
Nothing Rolls Like a Ball

NEW DEPARTURE BALL BEARINGS

158

MECHANICAL ENGINEERING, December, 1951, Vol. 73, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

For Editorial Contents See Page 963



What do you know about MoS_2* as a lubricant?

* Molybdenum disulfide

You have probably heard reports, some enthusiastic, some conservative, of the remarkable properties of Molybdenum Disulfide as a new lubricant.

For those who wish to review published information on this subject, we have compiled a 55 page publication containing excerpts from authoritative technical papers. Copies are free—write now.

Please send your FREE Booklet
"MOLYBDENUM DISULFIDE AS A LUBRICANT"
BLOCK LETTERS PLEASE

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Position ....

Company ....

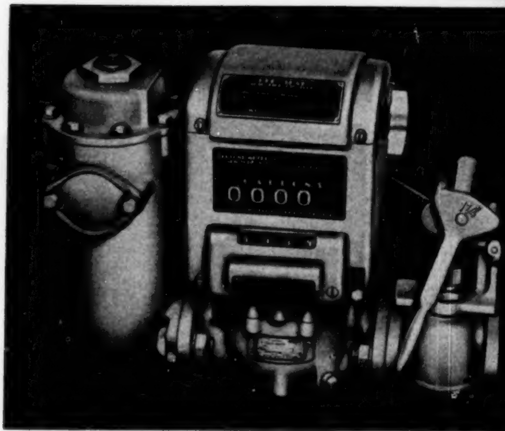
Address ....

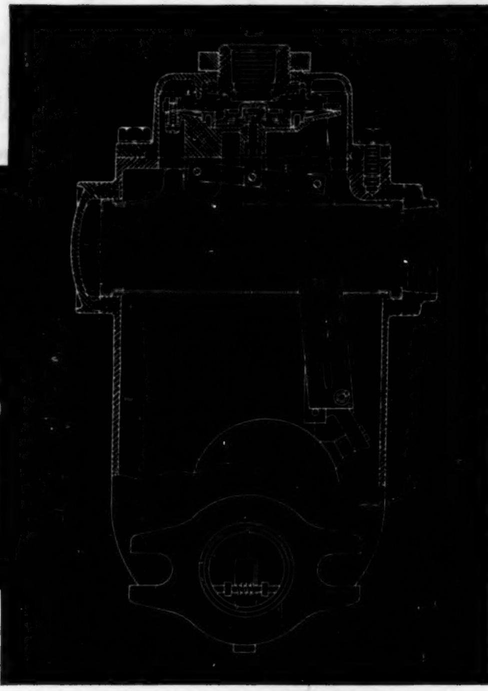
....

ME-12

Climax Molybdenum Company
500 Fifth Avenue · New York City

MS1





TIP...

FOR THE DESIGNER

Always Ready for Action With... LINEAR "O" RINGS

The drying out of gaskets in meters stored for even short periods is a common trouble. It is costly, too!

The makers of Neptune Compact Meters for tank trucks licked this problem with Linear "O" Rings . . . eliminated the need for disassembling and re-assembling meters before they could be put into service. Exhaustive tests showed that no leaks occur even well beyond standard test pressures. And years of service *on the job* confirmed test results.

This is another example of what can be accomplished with Linear "O" Rings in advanced engineering and design. The substitution of Linear "O" Rings for conventional compression gaskets in Neptune Meters provided a perfect seal with *metal-to-metal* contact between flanges. This means an end to the need for periodic checking and tightening of bolts . . . less down-time and repair expenses due to gasket failure . . . simplified and much less expensive inspection procedures. Many a sealing problem becomes no problem at all when Linear "O" Rings replace conventional gaskets!

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and "Silastics" . . . are molded in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes and special shapes. Precision molded under rigid laboratory control, Linear "O" Rings may be depended upon for continuous and lasting service.

It will pay you to consult Linear during the design stages of your sealing applications.

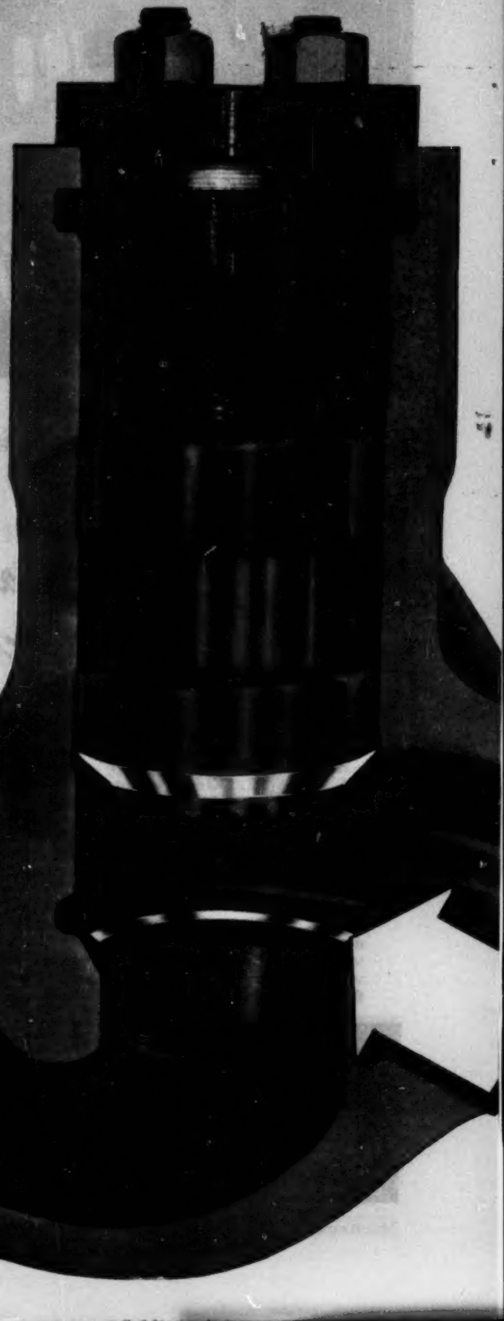
"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

Only Edward Has Integral Seats

FOR ALL HIGH PRESSURE—HIGH TEMPERATURE REQUIREMENTS



Pioneer in the valve industry in the use of Stellite hard facing for seats and disks, only Edward has the experience and the intricate equipment to build trouble-free extreme service valves with integral hard facing in a full size range.

No more leakage between valve seats and bodies, no more loosened or distorted seats, regardless of pipe size, service, or valve type.

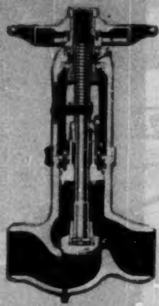
For high pressure—high temperature service, integral valve seats pay for themselves a dozen times over. So, Edward makes them standard construction in the higher temperature ranges, optional for moderate temperature service, and has them available in globe, angle, gate, non-return, instrument and other valve types in a full size range. Integral seats are leakproof seats. There are no threads to corrode—no points for erosion to start—no welds on seat rings to fail. An integral seat valve in a clean piping system needs no maintenance—no replacement.

For sizes, types and ratings write for Edward catalog 104.

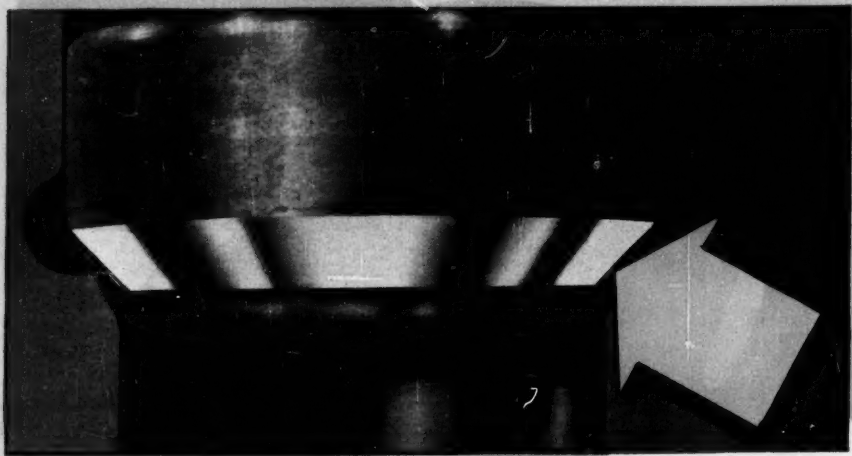
EDWARD—"BIRTHPLACE OF BETTER VALVE DESIGNS"

In a Full Range of Valve Sizes

Specify Edward valves with integral, hard-surfaced seats across the board, for Edward and only Edward gives you this permanently tight, leak-proof feature in every steel valve size from ½ in. to 16 in.



See how the Edward integral seat is part and parcel of the valve body itself. Stellite is applied by weld deposit on the machined valve body seat area. The entire body is then heat treated to remove stresses and prevent distortion. Next, the seat is machined to mirror-smooth finish and exactly mated to the hard faced disk.



WITH AN INTEGRAL SEAT THERE ARE **NO LEAKS** BETWEEN SEAT AND BODY

FEATURES LIKE THIS SAVE YOU TIME, TROUBLE AND MONEY...

IT PAYS TO SPECIFY EDWARD VALVES

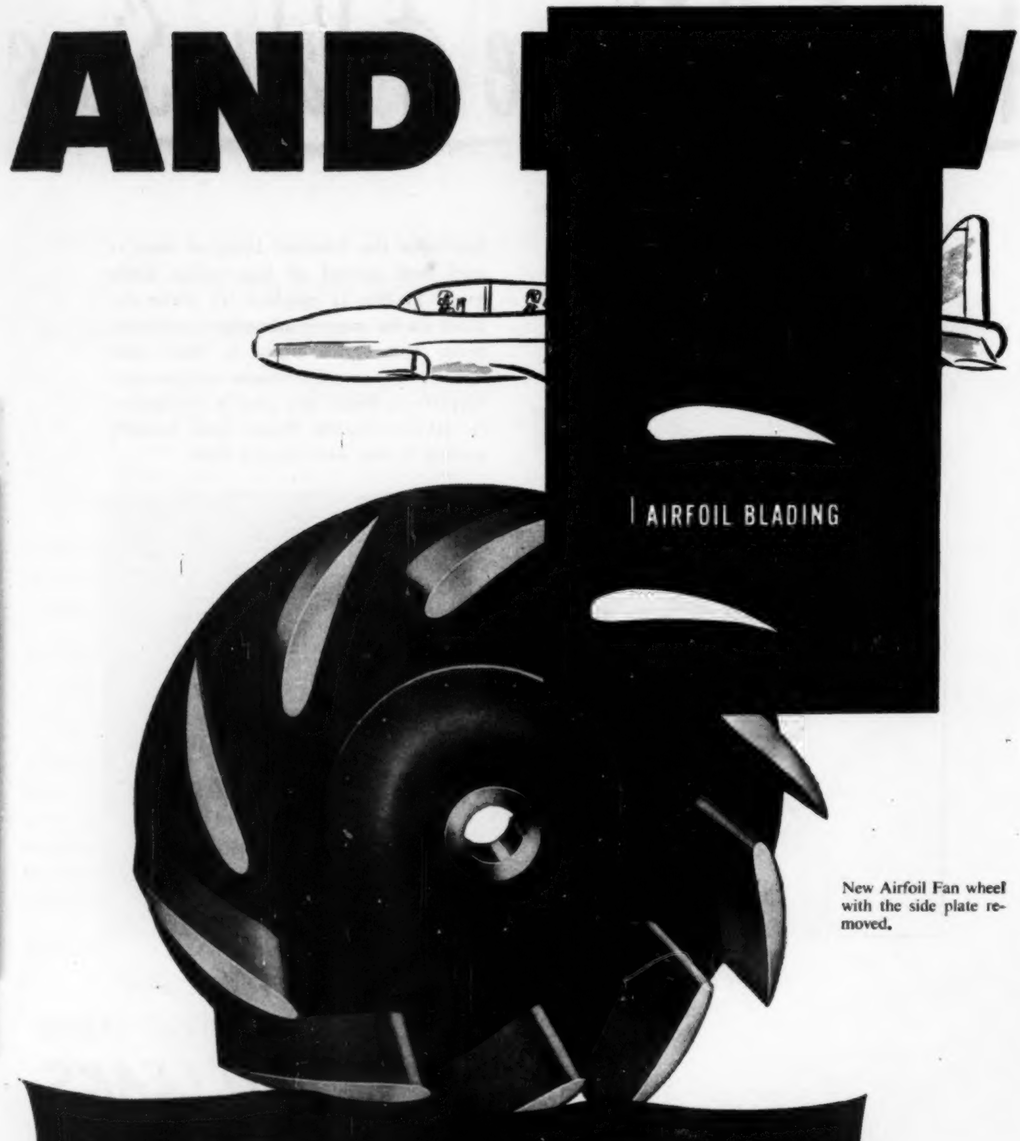
Another Ⓡ Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1350 West 145th Street

EAST CHICAGO, INDIANA



New Airfoil Fan wheel with the side plate removed.

A CENTRIFUGAL FAN WITH AIRFOIL BLADING

Sturtevant Pioneers Again
Here's another major advance in fan design by Sturtevant—the new Airfoil Non-Overloading Centrifugal Fan.

In 1914, Sturtevant made high efficiency possible with the non-overloading centrifugal fan—the TURBOVANE®. Then, in 1930, low-cost Sturtevant VANE CONTROL® increased the efficiency of part-load operation. Now, in 1951, the new Sturtevant Airfoil blade achieves new heights in peak efficiency with "the wings of an airplane" housed in a centrifugal fan.

Higher Efficiency and Quieter Operation
Sturtevant's scientific application of Airfoil Blading produces a new high in efficiency and a new low in noise level:

Efficiency . . .	90% plus
Noise Level . .	65% less

Wherever operating cost means more than first cost—where evaluation and a reasonable price mean more than a low price—the Sturtevant Airfoil, Non-Overloading Fan is the answer.

Recent Purchasers
Airfoil Fans were selected by the Consolidated Edison Company of New York for their Astoria and East River Plants, and have been *successfully witness tested.* Other orders have been received from Duke Power Co., New York Gas & Electric Co., Pennsylvania Electric Co., Tennessee Valley Authority, and also for ventilation of the new Squirrel Hill Tunnel in Pittsburgh.

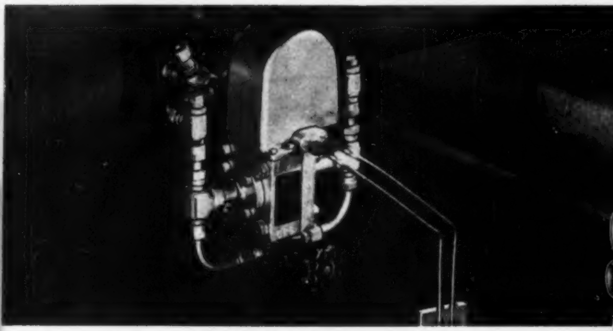
Where To Use
If low operating cost is of primary importance to you in your air handling applications, as it is in mechanical draft for utility and industrial power plants, in high-velocity air conditioning systems, and for vehicular tunnel ventilation, this new fan is available to you. For full information, contact your local Westinghouse-Sturtevant office, or write to Westinghouse Electric Corporation, Sturtevant Division, 167 Damon St., Hyde Park, Boston 36, Massachusetts.

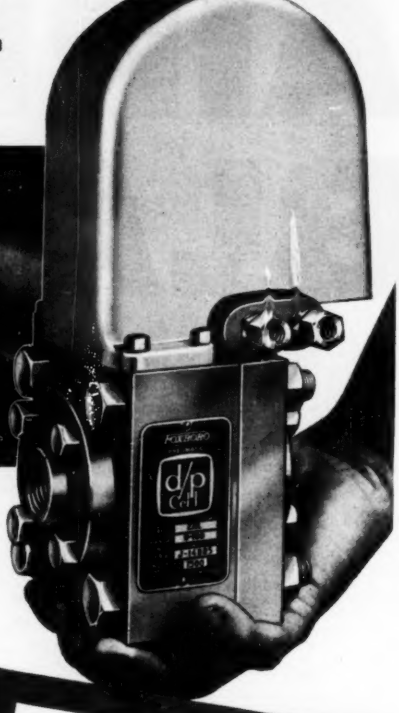
YOU CAN BE SURE...IF IT'S Westinghouse

J-80244

Simplest Flow Measurement

with the ALL-METAL Foxboro d/p Cell!





. . . gives fastest response, longest sustained accuracy, lowest installation cost

Simpler in design, simpler and much less expensive to install, far easier to maintain . . . the all-metal Foxboro mercury-less *d/p Cell* offers greater speed of response, permitting closer flow *control*, than has ever been possible before. Its negligible displacement and corrosion-proof construction of Type 316 Stainless Steel eliminate usual maintenance problems, even in service on highly corrosive or viscous fluids previously considered unmeasurable.

The Foxboro d/p Cell measures differential pressure by the force-balance principle and transmits pneumatically to indicating, recording, or controlling receivers. Small, compact, weighs as little as 19 lb. Ranges: from 25" to 800" H_2O. Working pressure ratings up to 4000 psi. Steel or stainless steel construction. Inherent over-range protection. Easy in-the-field calibration and range changes. Optionally available with pre-assembled manifold piping shown in photo above.

Thousands of d/p Cells now in use throughout industry, with many repeat orders now on our books, indicate the wide acceptance and successful performance of this revolutionary development for the measurement of liquid, steam, gas, or air flow. Write for detailed Bulletin 420. The Foxboro Company, 18212 Neponset Avenue, Foxboro, Massachusetts, U. S. A.

- No seal pots
- No mercury
- No leveling
- Installed at the orifice

FOXBORO

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RECORDING · CONTROLLING · INDICATING

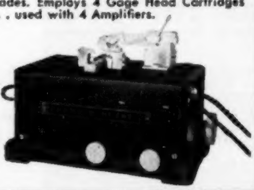
INSTRUMENTS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

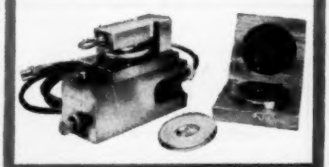
Adaptable Foundation for Countless Precision Gaging Set-Ups

TYPICAL APPLICATIONS

Special gaging fixture made by Brown & Sharpe for inspecting dimensions, side parallelism and side squareness of cutter blades. Employs 4 Gage Head Cartridges . . . used with 4 Amplifiers.



Special gaging fixture, custom-made by Brown & Sharpe, permits gaging of meter valve plate flatness to .00001", when used with Brown & Sharpe Amplifier.



Custom-made fixture, employing Brown & Sharpe Gage Head Cartridge and one Amplifier, measures major and minor I.D.'s of tapered bores; indicates internal angle accuracy.

Brown & Sharpe Gage Head Cartridge and Electronic Amplifier

Here's a really practical basis for versatile precision gaging equipment at reasonable cost.

The Brown & Sharpe Gage Head Cartridge and Electronic Amplifier provide accurate gaging, with direct-reading indications, in units of .0001" to .00001". Simple jigs or fixtures to hold the cartridge for many special gaging jobs can easily be built in your own plant. By shifting the same cartridge among a number of fixtures, you can do precision gaging of practically any length, diameter, or other dimension — with minimum investment in equipment.

Both the Gage Head Cartridge and the Electronic Amplifier are built for severe service conditions. The dustproof, moisture-proof cartridge can be safely exposed to abrasives or coolant. Write for complete literature on this multi-use precision gaging equipment. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

WE URGE BUYING THROUGH THE DISTRIBUTOR

BS

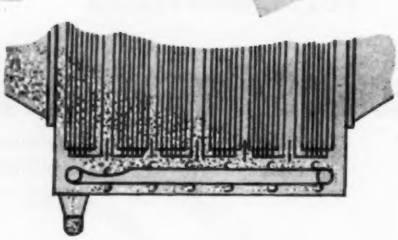
Brown & Sharpe

Let's be practical about precipitators

1

This Koppers "packaged" mechanical or vacuum tube power pack is not restricted to an area near the precipitator. It can easily be installed in any convenient place in the plant. Result: Compact designs! More flexibility!

2



This Koppers exclusive—the bottom drag scraper—provides continuous dust removal. Cumbersome hoppers are eliminated and dust handling is simplified. Result: Lower operating costs! Less space requirement!

Here are two ways Koppers engineers simplify precipitator operation for you!

PERFORMANCE GUARANTEED!

Koppers engineers protect your investment in an electrostatic precipitator by guaranteeing both the recovery or gas-cleaning *efficiency* and the *residual content* left in the gas after cleaning. Koppers-Elex electrostatic precipitators are designed, engineered, fabricated, erected and guaranteed *under one contract* by Koppers Company, Inc.

IN ADDITION to high efficiency, Koppers concentrates on the practical aspects of electrostatic precipitator design. Shown above are just two of the many practical features which simplify operation.

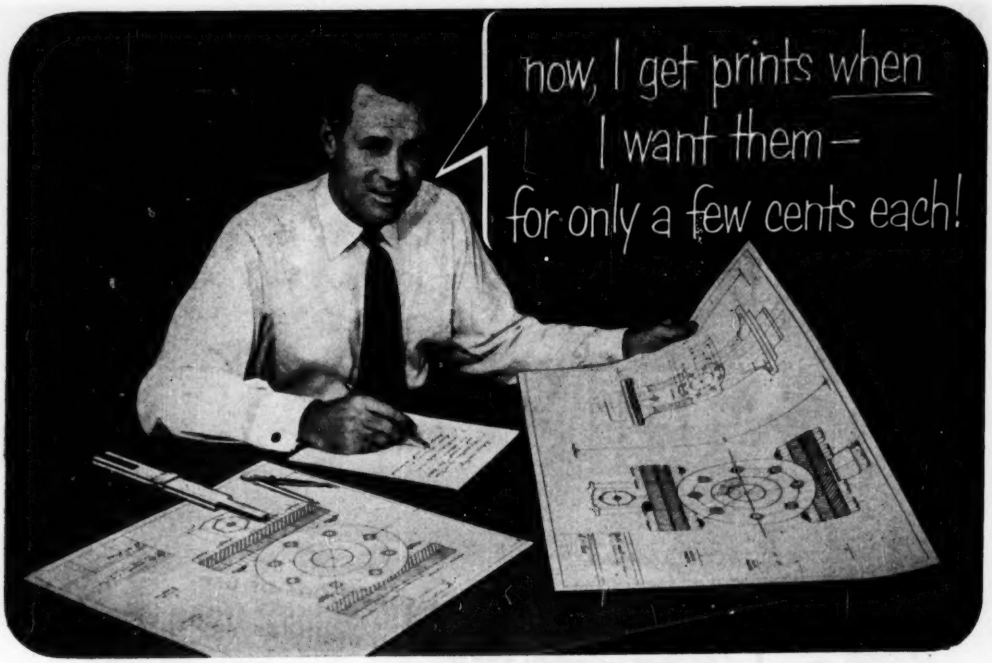
Besides these compact power packs and the continuous dust removal features, Koppers-Elex electrostatic precipitators may be of the multiple-chamber type. This means one chamber may be shut down for inspection or maintenance without stopping the gas-cleaning action. The dirty gas is simply diverted through other chambers where cleaning continues.

Because rapping is *sectionalized*, re-entrainment is minimized. And because successive collection fields can be separately *energized*, maximum voltage can be applied to each field—with higher gas-cleaning efficiency resulting. Pressure drops are negligible.

IF YOU HAVE A GAS-CLEANING PROBLEM, write and outline the details for us to review. There is no obligation. Just address your letter to: KOPPERS COMPANY, INC., *Precipitator Dept.*, 322 Scott Street, Baltimore 3, Maryland.

KOPPERS ®

Koppers-Elex ELECTROSTATIC PRECIPITATORS



NEW! the low-cost* COPYFLEX "20"

With this new, low-cost whiteprinter, the Copyflex "20", you no longer need wait for prints. You get them *when* you want them, *as* you want them—for only 2¢ (average) per. sq. ft.! And that includes *all* costs . . . material, labor, depreciation, etc.

The Model 20 is a completely new, medium volume machine that sells for the lowest price of any machine in its class. It has a full 46" printing width, takes cut or roll stock, and delivers completely developed, ready-to-use prints. It requires no installation, no special training to operate.

Besides making prints of your engineering drawings, it quickly copies production orders, specifications, accounting reports, and other vitally needed paperwork. See how the Model 20, or one of our other models, can help you. Clip the coupon now and you'll be on the road to faster copying – at substantial savings.

Compare these advantages:

- ***LOWEST PRICED** machine of its class available.
- **NO FUMES.** Bruning Copyflex machines use no vapor developer, therefore cannot possibly emit unpleasant fumes.
- **NO INSTALLATION.** No exhausts needed. Just connect to a 115 volt AC electric power circuit.
- **NO TRAINED OPERATOR NEEDED.** Your secretary, the office boy, or anyone else can operate a Copyflex without special training.

BRUNING

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☐ Send me full details on the Model 20 Copyflex.

☐ I would like to see a Copyflex machine demonstrated.

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City__________ Zone____ State______

Here's how YOU can help to

SPREAD THE SUPPLY OF STAINLESS STEEL

1 Let us know ALL the conditions of use.

2 Tell us what fabricating methods you'll employ.

3 Tell us when you will actually NEED the material in the shop.

4 Give us a choice of multiple sizes that will cut with minimum scrap loss and wastage.

5 Hurry your working scrap back to the mill.

ALL stainless producers are in the same boat. We have the capacity to melt much more stainless steel if we could get more alloying materials. So, our first concern—with your help—is to make as much stainless as possible from the alloys allotted to us.

For example, suppose that 18-8 Allegheny Metal (18% chromium, 8% nickel) is ordered for a job where a 17% straight chromium grade would actually satisfy the conditions of use and the fabricating methods employed. In effect, 1% of chromium and the 8% of nickel would be wasted—could have been used to make more stainless steel. That's where Points 1 and 2 above come in.

Our next concern, after selecting the right steel for the job, is to make sure it is used right—with the least amount of wastage in conversion or fabrication, and the least amount lying idle in stock or scrap. That's where Points 3, 4 and 5 come in.

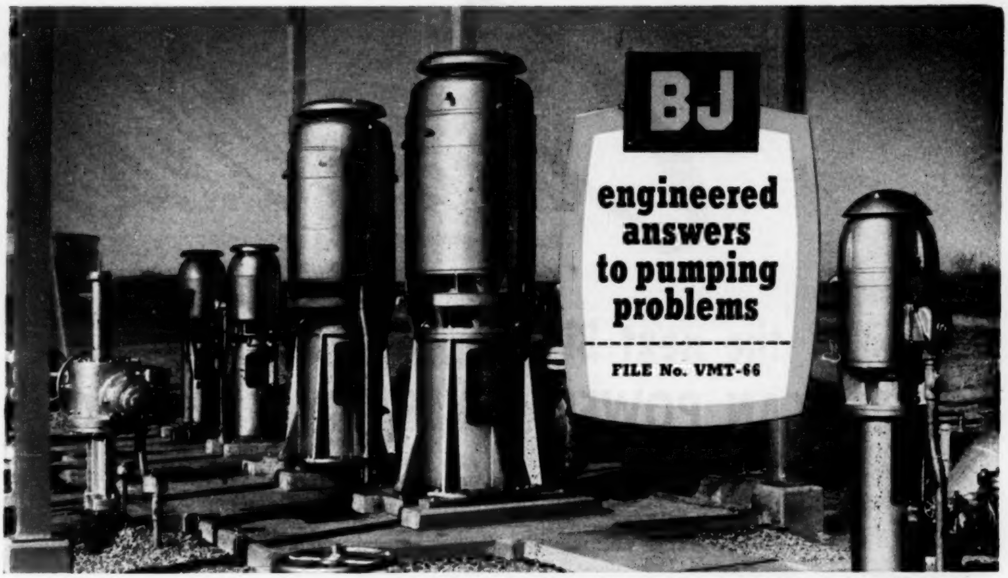
Help us to make this conservation program work, to help *you* get the stainless steel you need. ● *For any assistance, printed or personal, address Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

WSD 3693

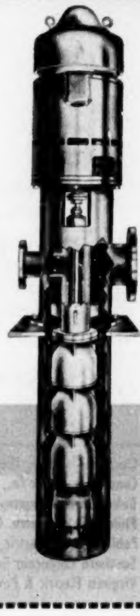
You can make it **BETTER** with

Allegheny Metal

AL TIME-TESTED STAINLESS STEEL



Boiling point temperatures and limited NPSH pose no problem for these VMT pumps!



When pumping fluids at boiling point temperatures, the problem of sufficient net positive suction head often requires expensive installation to raise the vessel from which the pump would draw or to excavate a pit to lower the pump.

This is eliminated with the BJ "VMT" pump because the vertical multi-stage pumping unit is mounted in a barrel from which it takes a suction. The base of the pump is at ground level while the length of the barrel is determined by the NPSH requirement.

The "VMT" pumps (shown above) serving as boosters from gasoline tank farm to main line stations are just one of the many successful applications for refineries, pipe lines, fueling stations, power plants, and process industries. For more detailed information on how the "VMT" may solve your pumping problem, call your local BJ sales office or send the coupon below.

FILE FACTS:

- Capacities to 5000 gpm. Heads to 250 psi. Temperatures from sub-zero to 750° F.
- Handles corrosive or non-corrosive liquids
- Radial forces balanced at all speeds
- Adjustable coupling for easy, accurate impeller setting

Also available in the smaller "VLT" model (capacities to 110 gpm). Provides the same basic construction and installation advantages as the "VMT," yet is priced for general purpose application.

Byron Jackson Co.

Since 1872

P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

OFFICES IN PRINCIPAL CITIES

BJ Pump Division, Dept. 24
Please send me Bulletin No. 51-6600 on your VMT pump.

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FIRM____________________

ADDRESS____________________

CITY__________ ZONE____ STATE________

Controlled

the next Big step forward in
AMERICAN POWER GENERATING PRACTICE

Within three decades the electric utility industry has reduced its average heat rate by 65 per cent – from about 40,000 Btu per kw-hr to about 14,000. And rates approximating 9000 are indicated for the most efficient stations now being designed.

On the steam generating side, this amazing progress is attributable to certain major advances of the period. These include . . .

- pulverized coal firing
- water-cooled furnaces
- preheated combustion air
- integrated boiler unit designs
- higher pressures
- higher temperatures
- improved firing equipment
- reheat
- improved methods and means of control

Combustion Engineering–Superheater, Inc., has been prominently identified with all these advances.

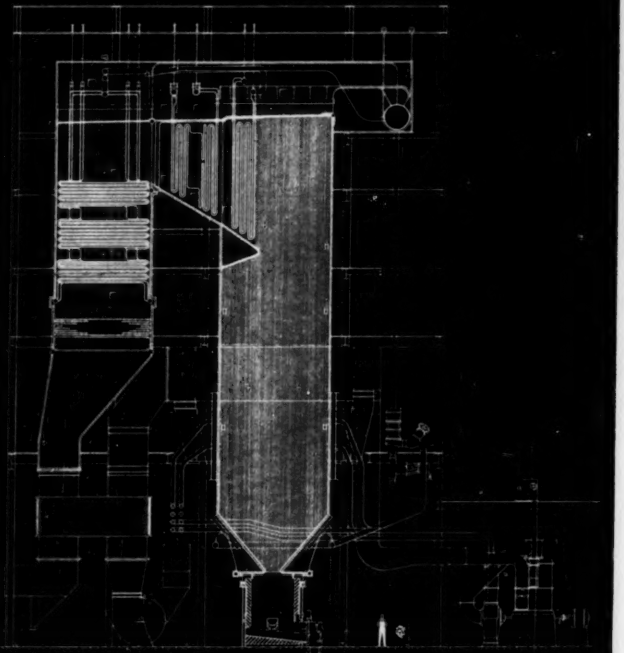
With this background Combustion offers the principle of controlled circulation as the next big step forward in power station practice. It does so with the confidence born of more than 10 years of development and operating experience. That this confidence is shared by leading utility engineers and their consultants is evidenced by the following contracts, placed since mid-1950, for . . .

eighteen C-E Controlled Circulation Boilers to serve an aggregate capacity of 2,500,000 kilowatts.

Company and Main Office	Station	Capacity per unit lb of steam per hr	Design Pressure	Steam Temp. primary-reheat
Cleveland Electric Illuminating Co., Cleveland, Ohio	East Lake	875,000	2030	1000 – 1000
Consumers Power Co., Jackson, Michigan	Weadock	1,050,000	2300	1050 – 1000
Duke Power Company, Charlotte, North Carolina	Buck	900,000	2010	1000 – 1000
Philadelphia Electric Company, Philadelphia, Penna.	Cromby	1,450,000	2075	1000 – 1000
Public Service Electric & Gas Co., Newark, New Jersey	Kearny	1,015,000	2650	1100 – 1050
Southern California Edison Co., Los Angeles, Calif.	Etiwanda	920,000	2100	1000 – 1000
Virginia Electric & Power Co., Richmond, Virginia	Chesterfield	750,000	1670	1000 – 1000
	Gilmerton	750,000	1670	1000 – 1000
Wisconsin Electric Power Co., Milwaukee, Wisconsin	Oak Creek	795,000	2050	1050 – 1000

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



ADVANTAGES

The major characteristics of the C-E Controlled Circulation Boiler are (1) the maintenance of positive, high velocity circulation in all circuits, under all operating conditions, (2) the proper proportioning of water supply to all heating circuits, and (3) the use of small-diameter, thin-wall tubes. These characteristics provide many design and operating advantages, the principal ones being:

DESIGN

- **Permits the use of pressures considerably beyond the practical limits of natural circulation boilers**
- **Introduces new flexibility in proportioning of unit to fit existing space conditions or to reduce height and therefore cost of new plant structures**
- **Permits the use of bare furnace walls regardless of pressure**
- **Provides a substantial reduction in weight of pressure parts, and therefore of structural supports**

OPERATION

- **Maximum availability**
- **Faster pick-up or drop of load**
- **Reduced outage time for inspection or maintenance**
- **Higher plant safety factor**

PREDICTION: **The decade of the fifties will be marked by the ever increasing recognition of controlled circulation as a major advance in power station practice and by its wide adoption for the higher range of pressures.**

B-528

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

FOOTE BROS. *Enclosed Gear Drives*

HIGHEST IN QUALITY • SUPERIOR IN PERFORMANCE

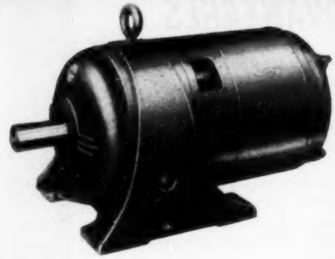
WIDE RANGE OF TYPES AND SIZES

Enclosed Gear Drives—a size and type to meet every application. The latest in gear-cutting equipment backed by nearly a century of engineering and manufacturing experience. New techniques, better control of material, improved manufacturing methods—all assure superior enclosed gear drives.

LINE-O-POWER STRAIGHT LINE DRIVES

Available for prompt delivery

High quality Duti-Rated Gears permit maximum power in minimum size. These drives are economical, both in original cost and operation. Double or triple reductions with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 h.p. Write for Bulletin LPB.



FOOTE BROS.—LOUIS ALLIS GEARMOTORS

Available for prompt delivery

Duti-Rated Gears with file hard tooth surfaces and resilient cores assure long wear life and maximum load-carrying capacity. Wide range of highest quality motors in open drip-proof, splash-proof, enclosed and explosion-proof types. Write for Bulletin GMA.

HYGRADE HORIZONTAL WORM GEAR DRIVES

Available for prompt delivery

High in quality, compact in design, incorporating precision worm gearing. Available in a wide range of types to meet any need. Ratios from 4⅛ to 1 up to 4108 to 1. Capacities up to 260 h.p. Write for Bulletin HGB.

HYGRADE VERTICAL WORM GEAR DRIVES

Available for prompt delivery

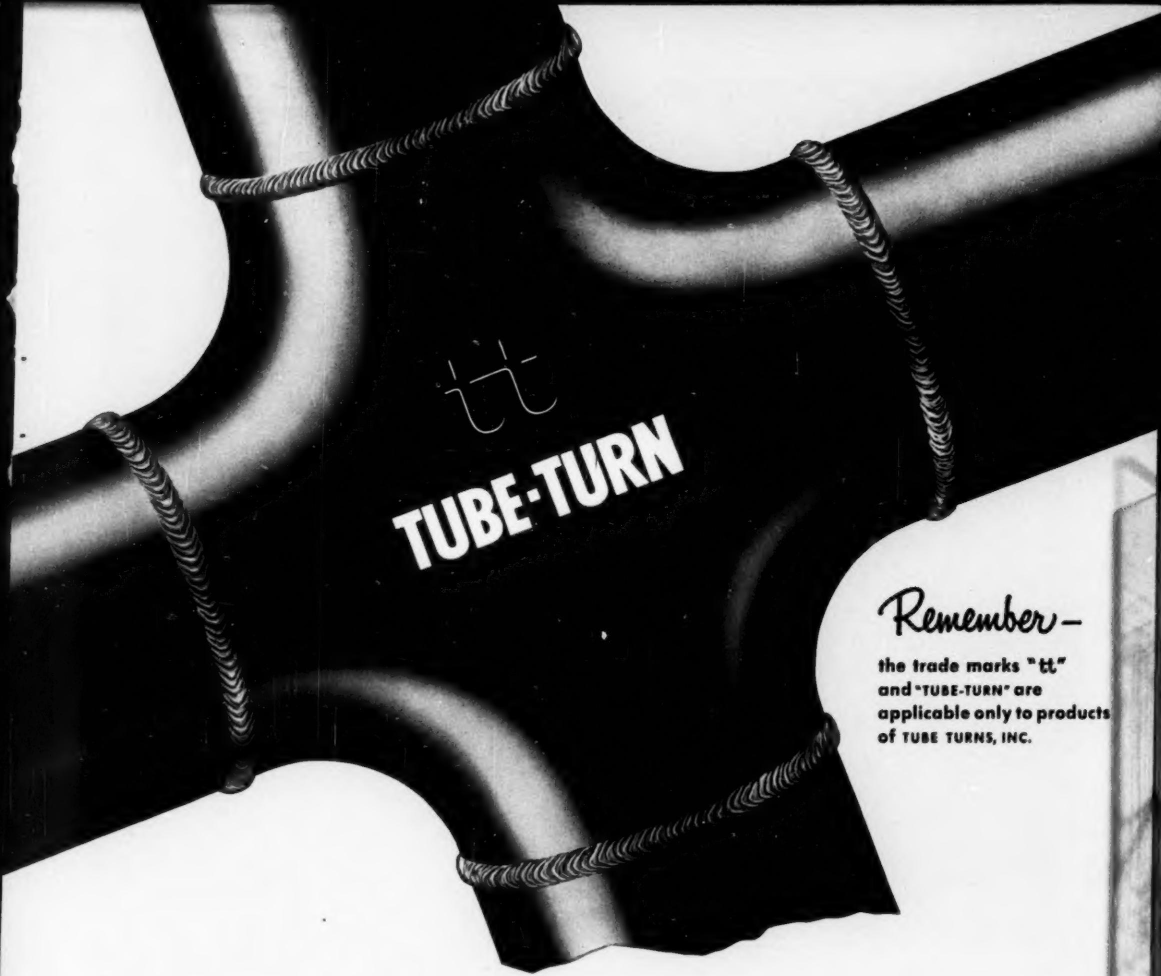
Vertical output shafts extended either upward, downward, or both. Also available in Hytop design with wider low speed bearing span to accommodate vertical output shaft extensions. Ratios 4⅛ to 1 up to 4108 to 1. Capacities up to 260 h.p. Write for Bulletin HGB.

WRITE FOR INFORMATION...

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS.
GEAR AND MACHINE CORPORATION
4545 S. Western Ave.
Chicago 9, Illinois



Remember—

the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

It's a neat job . . . and it's stronger

● Welded piping systems are streamlined. They save space, are easier to insulate and are permanently leakproof.

For a complicated connection like this, use of the TUBE-TURN Welding Cross also means extra strength. This welding cross is made from the same seamless tubing and by the same process as TUBE-TURN Welding Tees. Bursting pressures obtained in tests of representative tees and crosses have averaged more than 25% higher than required by standard codes. This gives you extra quality at no extra cost.

Welding your piping with TUBE-TURN Welding Fittings means a neater design and stronger construction. Get in touch with your nearby TUBE TURNS' Distributor. There's one in every principal city.

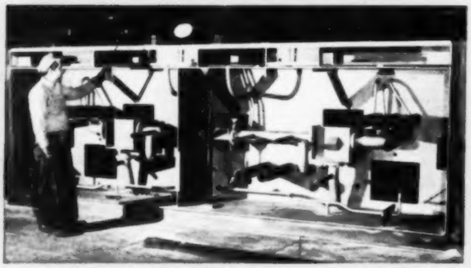
Write Dept. F-12 for free booklet, "Allowable Working Pressures".

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

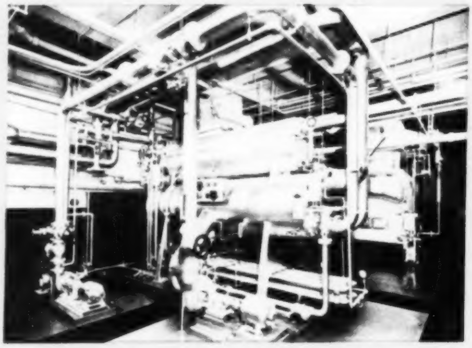
DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO . . . A wholly owned subsidiary of TUBE TURNS, INC.

They build piping permanence into this equipment...
...with TUBE-TURN Welding Fittings

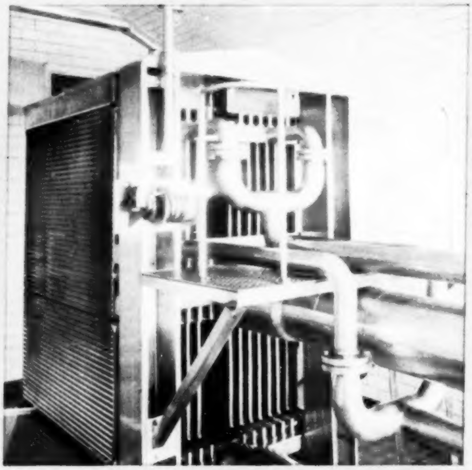


Hydroelectric projects like Grand Coulee and Hoover Dam represent a tremendous investment in equipment. So the Woodward Governor Company, builder of governors which control the big turbines, makes dependability a prime consideration. Critical piping on the governor sump base is joined with reliable TUBE-TURN Welding Fittings.

Here's the first gas turbine electric locomotive on the nation's railroads. With much of the equipment fitted into a limited space, failures in piping joints here would mean king-sized headaches. That's why piping joined with TUBE-TURN Welding Fittings is specified throughout. Despite hard usage characteristic of locomotive application, this piping stays strong.



Carrier Corp. engineers insist on rugged components for Carrier apparatus, such as this new refrigerating machine. Thus lines are welded with TUBE-TURN Welding Fittings to banish maintenance, conserve space too. The wide range of types, sizes, and alloys available in TUBE-TURN Welding Fittings and Flanges makes fabrication of a complex job like this easier.



A cool, clean bottle of beer starts with clean, leakproof equipment. That's why welded piping is used for this wort cooler, designed and used by the Falstaff Brewing Corporation. Pipe and TUBE-TURN Welding Fittings are made of stainless steel. Thus contamination, internal or external, is guarded against. Such installations assist Falstaff's premium quality control program, and help keep the plant spic and span.

TUBE TURNS, INC., Dept. F-12
224 East Broadway, Louisville 1, Kentucky

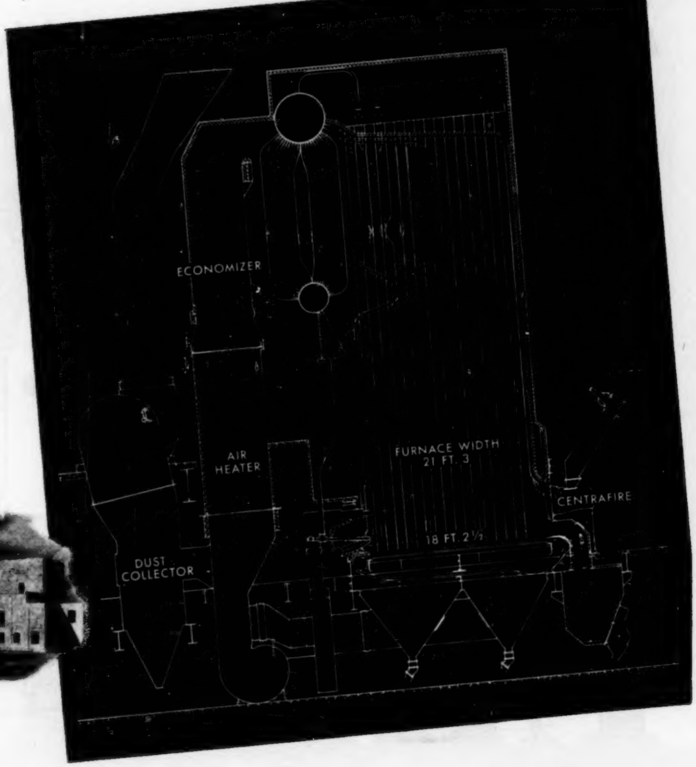
Your Name ....
Position ....
Company ....
Nature of business ....
Address ....
City .... *State* ....

DISTRICT OFFICES

New York	Houston
Philadelphia	Tulsa
Pittsburgh	San Francisco
Chicago	Los Angeles

"tt" and "TUBE-TURN" Reg. U.S. Pat. Off.

TUBE TURNS, INC.
LOUISVILLE 1, KENTUCKY



Engineers for the Bay Front Steam Plant of the Lake Superior District Power Company at Ashland, Wisconsin, were Sargent & Lundy. The Westinghouse Centrafire with Traveling Grate will carry a constant load of 200,000 lbs. of steam per hour, with peaks of 230,000 lbs. of steam per hour.

CONSTANT LOAD 200,000 lbs. per HOUR... another Centrafire triumph!

The Westinghouse Centrafire® with Traveling Grate now being installed for the Lake Superior District Power Company is one of the largest Centrafire units that has been ordered to date. This utility and their consulting engineers wanted a stoker that could maintain a constant load of 200,000 lbs. of steam per hour . . . with peaks of 230,000 lbs. of steam per hour . . . despite continuous feeding of wet and storage coal. Moreover, they needed a stoker that could absorb foreign objects in the coal, without interruption or damage to the apparatus.

The ability of the Centrafire to "take it" and continue without load loss under severe conditions has been demonstrated in factory tests and in power plant installations. Wet coal, storage coal, bricks, blocks of wood, insulators, cable, bolts and many other foreign objects have been deliberately introduced into the feeders with no adverse effect.

There are many other features that make the Centrafire outstanding . . . they're built into the basic design, not added as accessories. Whether your application calls for 50,000 lbs. of steam per hour . . . or 350,000 . . . the Centrafire with Traveling Grate offers advantages you should investigate. Call your nearby Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

J-30537

Westinghouse

STOKERS

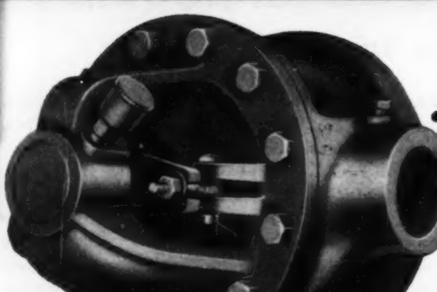
when the ACCENT is on the Positive.

. . . then the positive pumping of Fairbanks-Morse Rotary Pumps offers the best choice for your equipment. They efficiently handle any free-flowing liquid from gasoline to molasses with exceptionally high efficiency. Non-fluctuating load characteristics minimize shock and vibration . . . assure long, economical service.

Only TWO parts move in Fairbanks-Morse Rotary Pumps . . . a precision-cut rotor and pinion gear. There are no complicated parts to cause trouble or to require frequent maintenance and adjustment. Capacities range from ⅜ to 5 inches. If your design problems involve positive pumping, choose from the Fairbanks-Morse Rotary Pump line . . . the economical choice.

FAIRBANKS

A NAME WORTH



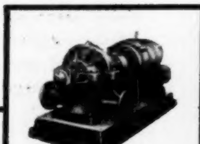
..when HEADS are up or down

A Fairbanks-Morse Westco turbine-type pump is the efficient answer. The unique design employed in these exceptionally compact pumps permits them to handle widely varying heads with little or no loss of capacity. Maximum capacity is obtained at an operating speed of 1750 r.p.m. when discharging at low pressure, and high pressures are developed at the same speed with little change in capacity. In addition, through the use of a single-stage, multi-vaned impeller, Westco Pumps give you multi-stage performance from a single-stage pump. Westco Pumps are widely used as integral parts of machines, units or systems. Capacities from 1 to 200 g.p.m. Check them for your equipment.

Other FAIRBANKS-MORSE Pumps Include

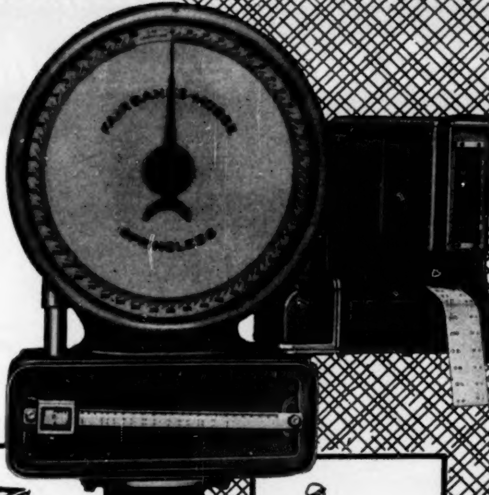
Builtogether Centrifugals

Side-Suction Centrifugals



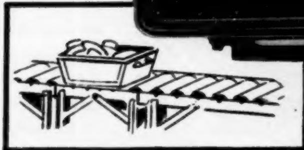
Single and Two-Stage Centrifugals

when it's a problem of CONTROL



. . . consider the advantages of control by weight! Fairbanks-Morse Printomatic Weighers with electronic attachments accurately control production and processing operations. Materials handling operations, conveyor systems, processing and batching operations can be accurately controlled by these precision instruments. They can open and close valves controlling material flows to predetermined quantities. Templets can be used to preserve formula secrets when compounding mixes.

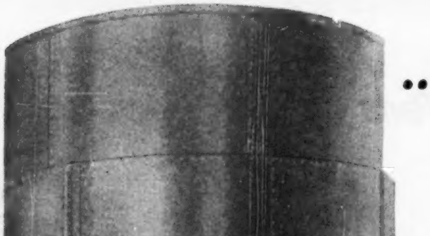
In addition, accurate records of materials can be kept since the Printomatic will furnish printed records of operations. The human element and chance for error are eliminated. Check your Fairbanks-Morse weighing expert on the advantages Printomatic offers you.



-MORSE

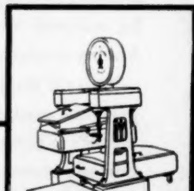
REMEMBERING

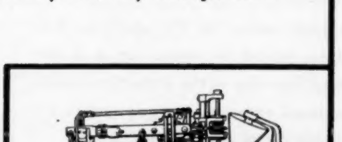
See Next Page for **FAIRBANKS-MORSE** Sales Centers



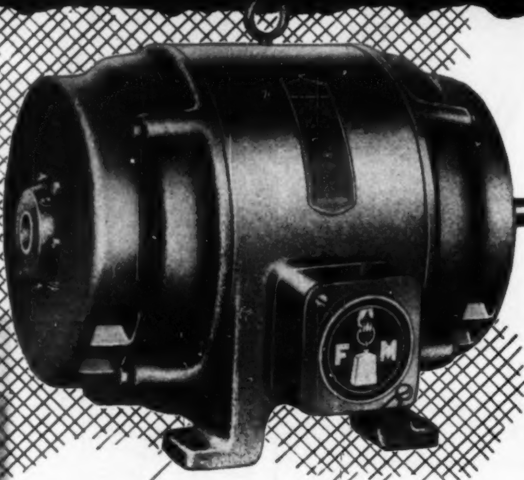
...when it's a problem in weight

. . . the easy answer is in the complete Fairbanks-Morse scale line. Beam scales or dials, belt conveyor scales, aggregate weighing scales, proportioning and batching scales, truck scales, furnace charging scales, you'll find them all and more. An important point—Fairbanks-Morse Scales *or component scale parts* can be supplied to fit right into your equipment for weight or control operations. Your Fairbanks-Morse weighing expert will be happy to work with you on any scale problem.





MOST Advantages for MOST Motor Applications



STANDARD DRIP-PROOF MOTORS FOR YOUR PROTECTION

Practically every motor needs protection—from flying chips, falling particles, dripping liquids, and the like. Also, by far the majority of motors used are of the polyphase, squirrel cage type.

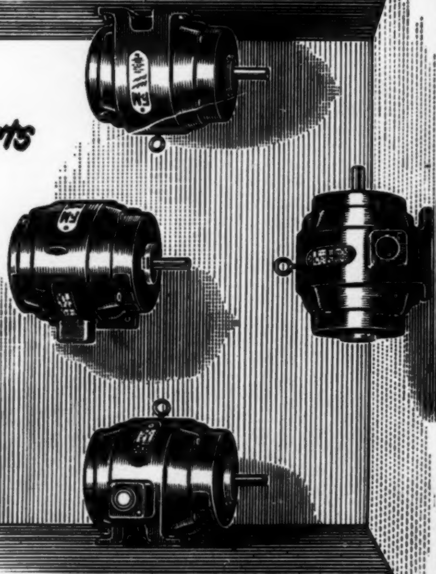
These requirements are met to a unique degree by this series of Fairbanks-Morse motors—with built-in protection and superior electrical and mechanical design that account for their popularity throughout industry.

Whether your motor application problems involve driving pumps, machine tools, compressors, elevators, fans—or any of an infinite number of other applications—Fairbanks-Morse Standard Drip-proof Motors deserve your early investigation. Call your nearest Fairbanks-Morse Sales and Service center.

FAIRBANKS

A NAME WORTH

PROTECTION.. *in any Position*
SAFETY.. *no Exposed moving Parts*



Mount these motors anywhere—even on the ceiling or walls. Bearing arms have four bolts spaced 90° apart, enabling the bearing brackets to be adjusted to assure maximum protection. Motor can be mounted vertically without any changes in bearing construction.

There is complete safety for the operator. Fingers can even be placed in vents, for it is not possible to contact fans due to the protective shield. Smooth, streamlined external contour makes the motor easy to keep clean, easier to maintain.

Cross Flow Ventilation...Copper Spun Rotor

...OTHER UNIQUE FEATURES

Cross Flow Ventilation is an exclusive Fairbanks-Morse design that eliminates hot spots, prolongs the life of the stator installation.

Copperspun Rotor: a truly one-piece indestructible copper winding that withstands higher temperatures, has high electrical and thermal conductivity, better dynamic balance.

Rugged Frame Construction: Protection in any mounting position.

General purpose continuous duty: rated 40° C. and designed to carry 115% load continuously without injurious heating (1.15% service factor).

High efficiency, high power factor, good starting and accelerating torques.

Unique conduit box provides alternate assembly: either recessed, flush with frame or conventional external mounting.

Mounting dimensions conforming to NEMA standards.

Arrows show double flow of air that keeps motors running cool!

-MORSE

REMEMBERING

THESE ARE YOUR FAIRBANKS-MORSE SALES CENTERS

ATLANTA 3, GEORGIA
760 Lee St., S. W.
AMhurst 7701

BALTIMORE 18, MD.
659 E. 25th St.
BElmont 5258

BIRMINGHAM 1, ALA.
626 N. Ninth St. Zone 4
3-6546

BOSTON 10, MASS.
178 Atlantic Avenue
LAfayette 3-3600

BUFFALO 3, N. Y.
33 Franklin St.
Lincoln 4210

CHARLOTTE 2, N. C.
Liberty Life Bldg.
Room 605
6-2893

CHICAGO 5, ILLINOIS
1550 S. State St.
HArrison 7-7100

CINCINNATI 2, OHIO
49 Central Avenue
MAin 3010

CLEVELAND 14, OHIO
3000 W. 117th St.
CLearwater 1-3300

COLUMBUS 8, OHIO
1034 Goodale Blvd.
WAlnut 8581

DALLAS 2, TEXAS
1713 N. Market Street
CEntral 4347

DENVER 2, COLO.
1500 17th Street
TAbor 6241

DES MOINES 17, IOWA
2017 Dean Avenue
6-1189

DETROIT 13, MICHIGAN
11110 East Warren Ave.
VAlley 1-7100

DULUTH 2, MINN.
Board of Trade Bldg.
2-7538

HOUSTON 13, TEXAS
5521 Navigation Blvd.
WAyside 2159—(LD 506)

INDIANAPOLIS 2, IND.
1499 N. Harding St.
FRanklin 3684
ATlantic 3092

JACKSONVILLE 6, FLA.
930 East Adams St.
5-6473

KANSAS CITY 7, MO.
1300 Liberty Street
Victor 6474

LOS ANGELES 11, CALIF.
4535 S. Soto Street
JEfferson 8151

LOUISVILLE 8, KY.
2008 So. Brook St.
CAlhoun 1469

MEMPHIS 7, TENN.
676 Jefferson Ave.
5-1614

MILWAUKEE 3, WIS.
404 N. Plankinton
DAly 8-0180

MINNEAPOLIS 15, MINN.
417 S. Fourth Street
MAin 4353

NEW ORLEANS 13, LA.
1000 St. Charles Ave.
RAymond 3115

NEW YORK 4, N. Y.
80 Broad St.
HAnover 2-7470

OMAHA 8, NEBRASKA
902 Harney St.
ATlantic 3122

PHILADELPHIA 8, PA.
401 N. Broad St.
WA 2-4100

PITTSBURGH 24, PA.
4301 Main Street
SChenley 1-3123

PORTLAND 14, OREGON
105 S. E. Taylor St.
EAst 0131

PROVIDENCE 3, R. I.
187 Pine Street
GAspee 1-1531

ST. LOUIS 2, MO.
217 South Eighth St.
CHestnut 7483

ST. PAUL 1, MINN.
220-26 E. Fifth Street
GArfield 4335

SALT LAKE CITY 1, UTAH
153 W. Second South St.
3-2108 & 3-5139

SAN FRANCISCO 7, CALIF.
630 Third Street
EXbrook 2-5855

SEATTLE 99, WASH.
Salmon Bay Terminal
ALden 6600

STUTTGART, ARK.
403 South Main St.
185

TULSA 3, OKLA.
1335 Hunt Bldg.
3-8231

WASHINGTON 5, D. C.
1000 Vermont Ave., N. W.
District 6694

FAIRBANKS-MORSE de MEXICO S. A.
Balderas 146, Mexico 1, D. F. Mexico
10 06 74 y 10 09 58

Export Division:
NEW YORK 4, N. Y.
80 Broad Street—HAnover 2-7470

SEND for this booklet on Vibration Control by Vibra-Mounts. It describes the new, simple, economical way to obtain up to 85% reduction in transmitted vibration, increasing plant efficiency, protecting machines, instruments, buildings and personnel. Vibra-Mounts can be installed quickly by superintendents and maintenance men.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN. ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.

NEW SOUND LEVEL METER

Improved Design

Accurate · Simple to Use

The new Type 1551-A Sound-Level Meter is very easy to handle. It weighs only 11 pounds, including its battery power supply. It is simple to operate requiring only the switch selection of the appropriate response characteristic, and then the adjustment of a single attenuator switch until the indicating meter stays on scale. The sound level is the sum of the attenuator and meter readings.

When not in use, the microphone folds back into the instrument panel, automatically turning off filament and plate voltages.

Type 1551-A Sound-Level Meter . . $360.00

MEETS ALL STANDARDS *of the American Standards Association, the A. I. E. E. and the Acoustical Society of America*

PORTABLE — *weighs only 11 pounds, with batteries*

SIMPLE TO OPERATE — *non-technical personnel can make just as accurate measurements as can anyone*

COMPLETE BATTERY OPERATION *from standard batteries, readily available*

VERY WIDE RANGE *of 24 to 140 db; will measure practically any noise level found in industry*

EXCELLENT STABILITY — *improved negative feedback amplifier circuits*

NON-DIRECTIONAL CRYSTAL-DIAPHRAGM MICROPHONE

TWO-SPEED INDICATING METER *for steady or rapidly fluctuating sounds*

EXCELLENT ACCURACY — *frequency response curves within current A.S.A.-specified tolerances; when amplifier sensitivity is standardized absolute accuracy of measurement is within ±1 db for average machinery noises*

INTERNAL CALIBRATING CIRCUIT — *sensitivity can be standardized at any time from any 115-volt a-c line*

WIDE FREQUENCY RESPONSE *of amplifier and panel meter — 20 cycles to 20 kilocycles*

LOW TEMPERATURE & HUMIDITY EFFECTS — *readings independent of both over normal room conditions (within 1 db)*

READILY USED WITH ACCESSORY INSTRUMENTS *such as graphic-level recorders, frequency and wave analyzers, magnetic-tape recorders*

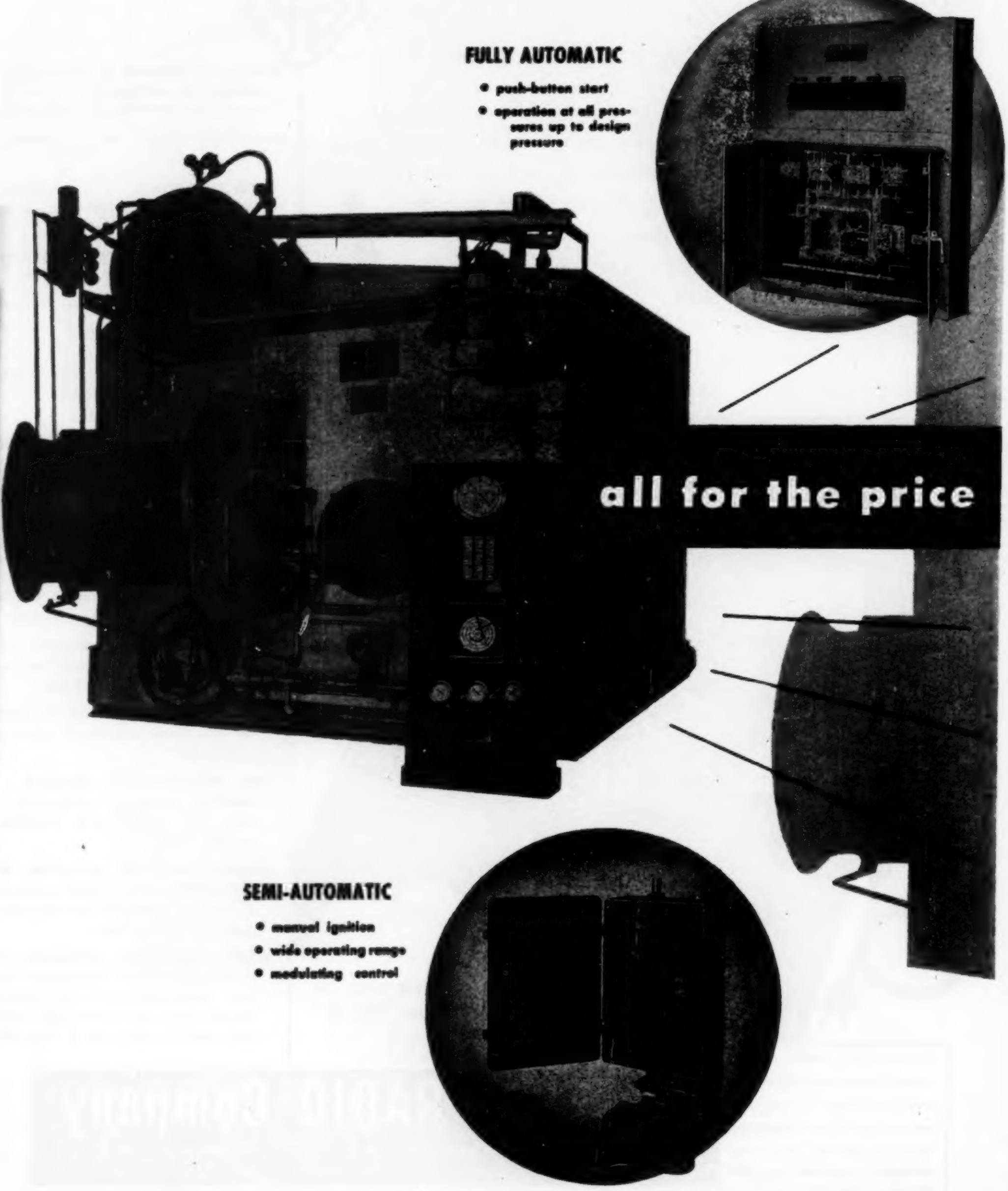
MANY ACCESSORIES AVAILABLE *for special applications; included are special microphones for high fidelity measurements, for reproducible standards and for use at end of long cable.*

STROBOSCOPES · VARIACS · SOUND-LEVEL METERS
VIBRATION METERS · IMPEDANCE BRIDGES
SIGNAL GENERATORS · OSCILLATORS
WAVE ANALYZERS · DISTORTION METERS
IMPEDANCE STANDARDS · VACUUM-TUBE
VOLTMETERS · FREQUENCY STANDARDS
BROADCAST MONITORS · PARTS AND ACCESSORIES

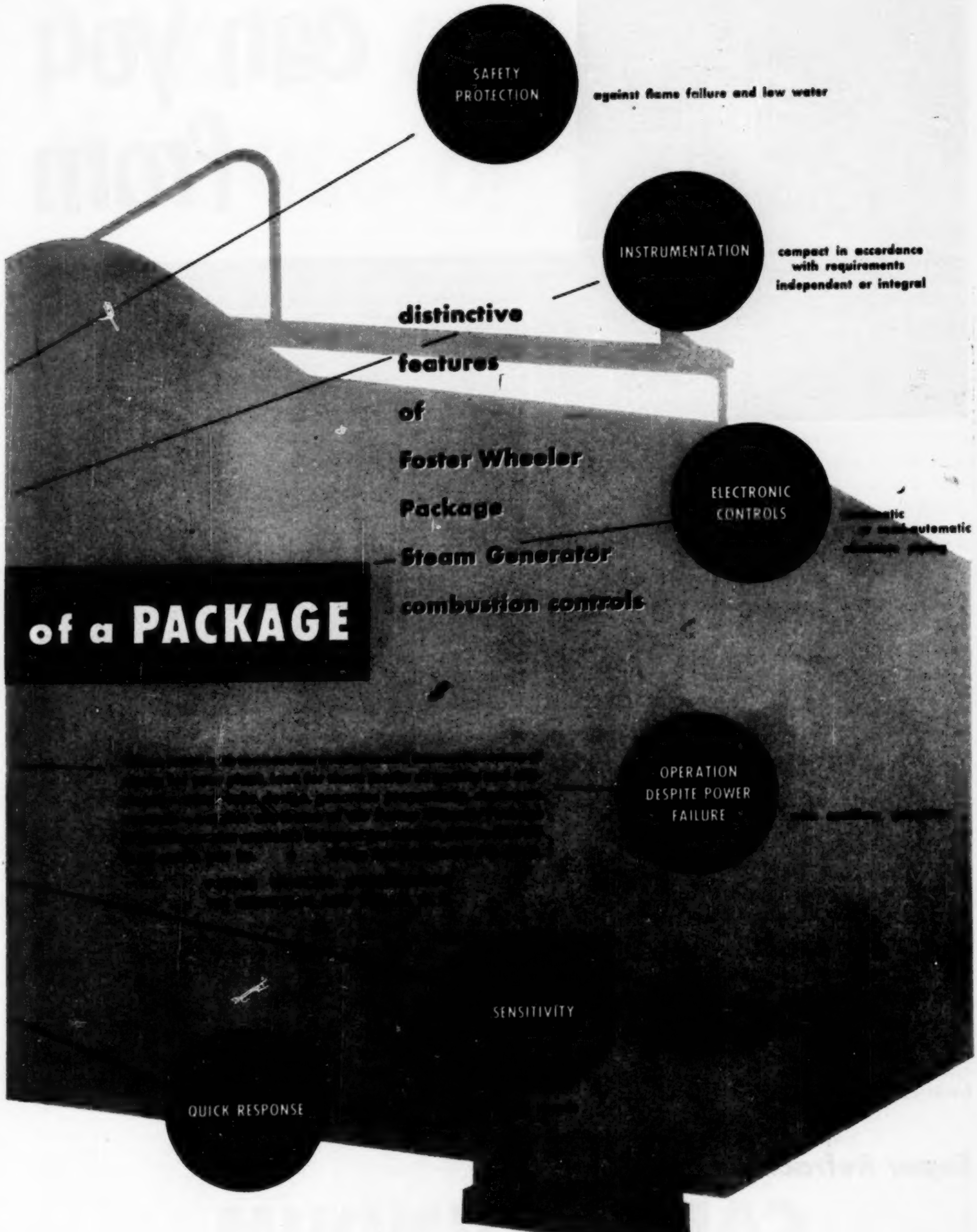
GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

Since 1915—Designers and Manufacturers of Electronic Test Equipment

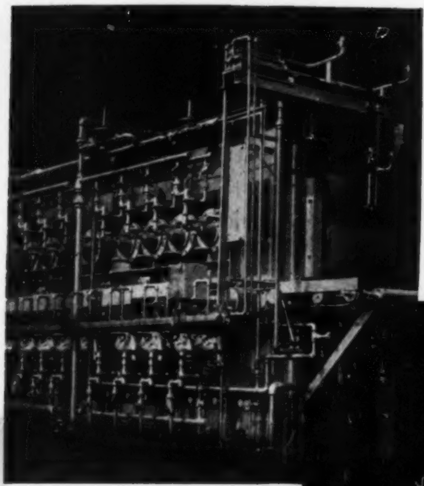


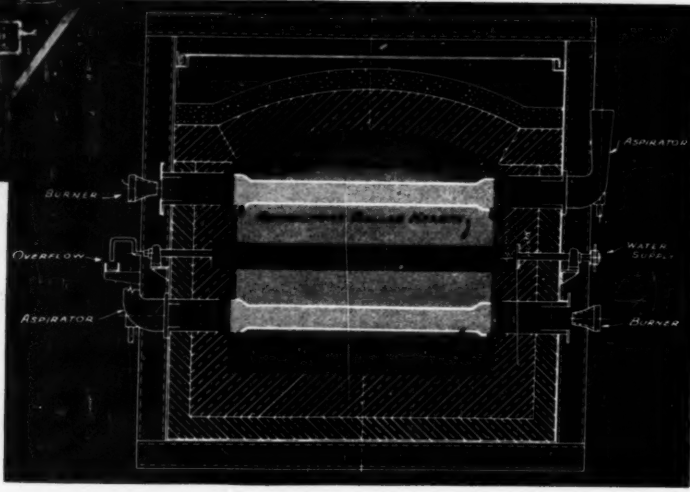
FULLY AUTOMATIC
• push-button start
• operation at all pressures up to design pressure
all for the price
SEMI-AUTOMATIC
• manual ignition
• wide operating range
• modulating control



FOSTER WHEELER

can you from





By using Super Refractories instead of alloys for radiant tubes and rollers, The Gas Machinery Co. opens up new applications for this furnace.

The furnace at the left is a controlled-atmosphere roller hearth furnace. Work, such as castings to be malleablized, moves through on rollers—is indirectly heated by radiant tubes above and below the hearth.

In furnaces of this type, the rollers and tubes are customarily made of heat-resisting alloy steel. Consequently, maximum operating temperature is about 1600 F. (Above this temperature, the strength and hardness of these steels fall off sharply.)

So, The Gas Machinery Company tried something different. Instead of metal, they used CARBOFRAX silicon carbide rollers and radiant tubes—a Super Refractory material made by CARBORUNDUM.

With these changes, temperatures of up to 2500 F, and more, become not only possible, but practical—and a whole new field of furnace usages opens up. Moreover, both the rolls and tubes last longer. In fact, the rollers (which used to sag and wear away) show hardly any signs of wear at all.

This application points up several properties of this highly unusual material. At elevated temperatures it *conducts* heat almost as well as heat-resisting alloy steels. It can be used at far higher temperatures than metals will stand—up to 3000 F

Super Refractories by

CARBORUNDUM
Trade Mark

Refractories Division **The Carborundum Company, Perth Amboy, N. J.**

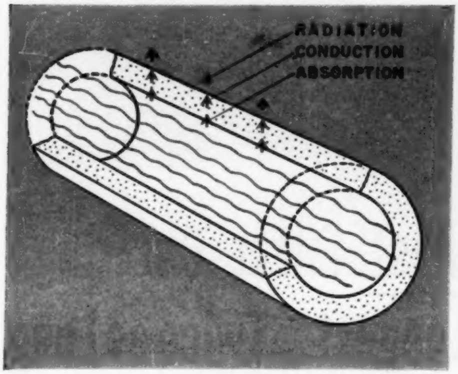
"Carborundum" and "Carbofrax" are registered trademarks which indicate manufacture by The Carborundum Company

pick up any ideas this use of tubes?

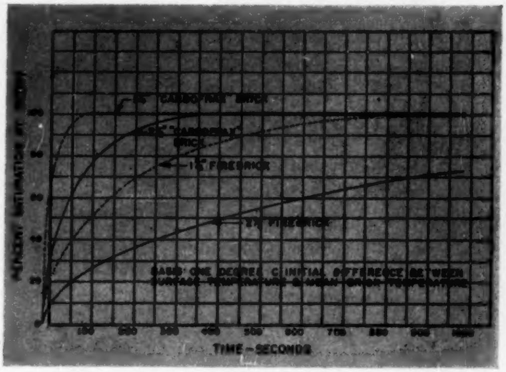
and higher. It doesn't scale, is very resistant to spalling and to heat shock. It is chemically inert—is little affected by the products of combustion—and is highly impervious to gases. It is also one of the most abrasion-resisting materials known. And it has the strength to support heavy charges, even at very high temperatures.

This illustrates the important thing about Super Refractories by CARBORUNDUM: They are not just "better" than standard fireclay refractories. They are actually a class apart—with distinctly different properties that have made possible distinctly new designs and processes. Once this concept is realized, possible applications are almost unlimited. The Gas Machinery Co., for example, now uses Super Refractories in several kinds of equipment, including an ingenious continuous catalytic gas reforming unit. Other companies also have developed interesting new equipment—designed around Super Refractories.

WHAT ABOUT YOUR OWN PROCESSES? We have a new booklet which outlines the unusual characteristics of these special-purpose materials. The coupon will bring you the story —or one of our engineers would be happy to talk over your specific problems. We believe it could be mutually profitable.



In indirect heating, absorption and emission factors come into play, as well as thermal conductivity. In both absorption and emission (and thus in radiating ability) CARBOFRAX tubes and shapes are superior to metal. They approach the high-temperature alloys in conductivity.



Thermal conductivity also plays an important part in checkers. A regenerator using CARBOFRAX brick for its checkerwork can be operated on much faster cycles—absorbing and releasing many times more BTU's per second. Also, higher temperatures, to above 3000 F if desired, become possible.

This advertisement — one of a series — is presented in the belief that in the unusual properties of Super Refractories by CARBORUNDUM lies the key to many new or improved processes. We would like to talk over specific jobs with anyone who sees such possibilities.

Dept. P-121

Refractories Div., The Carborundum Co.
Perth Amboy, New Jersey

Please send your free booklet on properties of Super Refractories.

Name________________

Position________________

Company________________

Street________________

City________ Zone____ State____

Less Expensive Micronic Filter Saves Space . . . Works Mechanically

For fluid filtration in the micronic range, many designers are now specifying Cuno MICRO-KLEAN.

In many cases, the MICRO-KLEAN turns out to be the most efficient—as well as the most economical—method of filtering many fluids.

The MICRO-KLEAN cartridge is a simple, compact structure of "felted" fibres, with no internal or external supports to take up space and complicate installation. It gets its strength from the resinous impregnation and polymerization. It won't swell or shrink, soften or harden, rupture or channel, or otherwise release contaminants into the discharge flow.

Fewer cartridge changes

MICRO-KLEAN's greater dirt-holding capacity comes from maximum porosity (85-90%) and from its exclusive "graded density in depth", permitting smaller particles to penetrate further, rather than "loading" the surface.

Cuno MICRO-KLEAN handles a wide range of fluids and flow rates with low pressure drop. It is guaranteed to remove 100% of all solids for which it is rated plus a large percentage down to 1 micron.

Capacities: a few to over 800 gpm. Single or multiple cartridge units. External or built-in application.

Cuno Engineering Corporation
Dept. 651C, South Vine Street, Meriden, Conn.

Please send information on Cuno MICRO-KLEAN for following installations ....

....

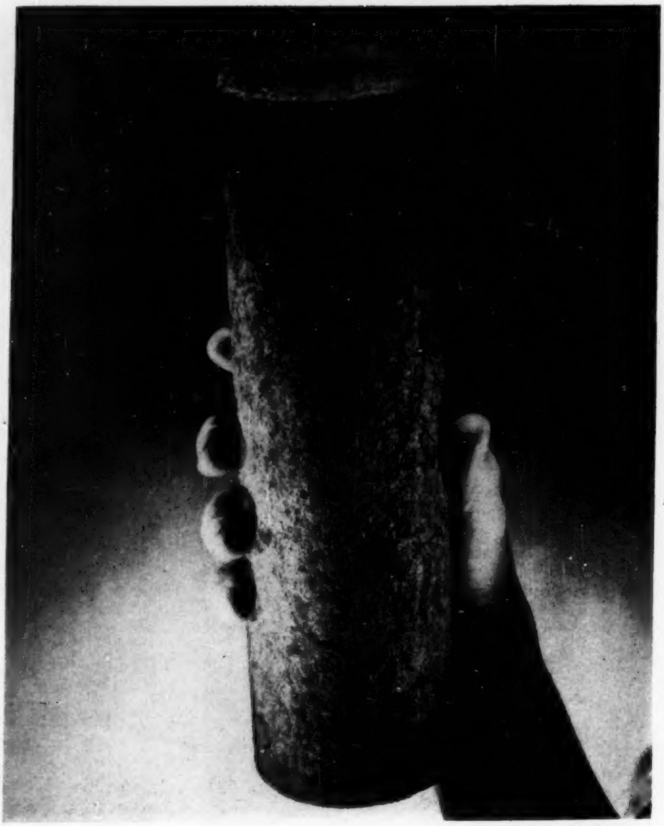
Name......................................

Company......................................

Address......................................

City................Zone....State.....

Please attach to business letterhead



The Simplest Filter Cartridge Lasts the Longest...Twice as Long

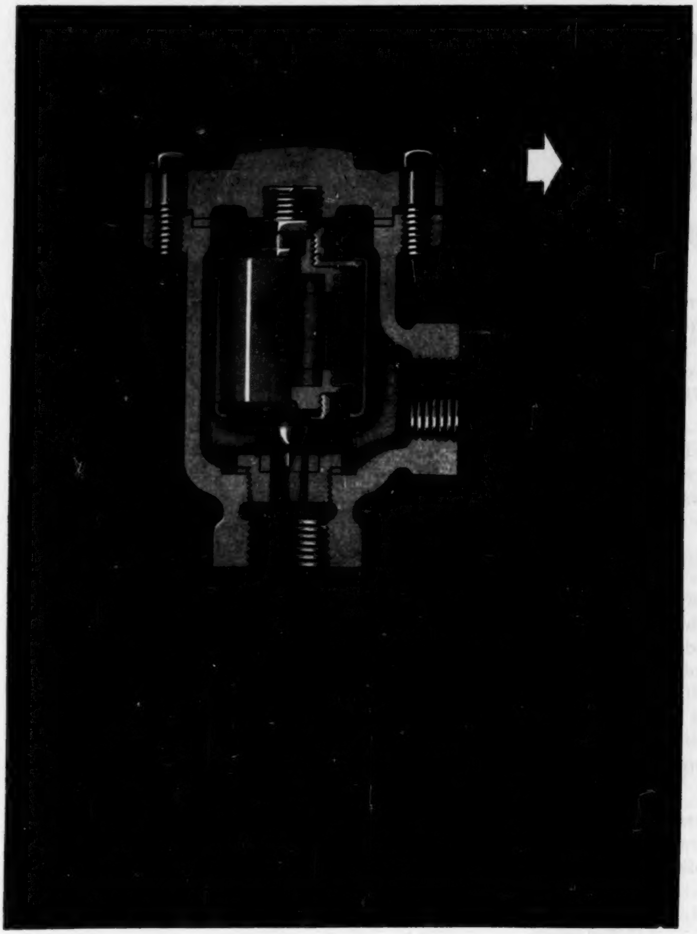
Cartridge renewals are cut at least *in half* when Cuno MICRO-KLEAN replaces any other filter. And throughout its service life, MICRO-KLEAN is *guaranteed* for specific performance.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN



STEAM FOR HEAT...

If you use steam for room or space heating or for any process, such as cooking, drying, evaporating or baking, you must necessarily use Steam Traps.

WHAT KIND OF STEAM TRAP?...

Of the many different types offered which should you choose?

SARCO MAKES 4 TYPES...

and can fit the trap to the job. We can give you unbiased advice, based on 30 years' field experience.

GIVE US FULL DETAILS...

on your trapping problem and let us pick the best type of steam trap for you, and tell you why.

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Multival Centralized System is standard equipment

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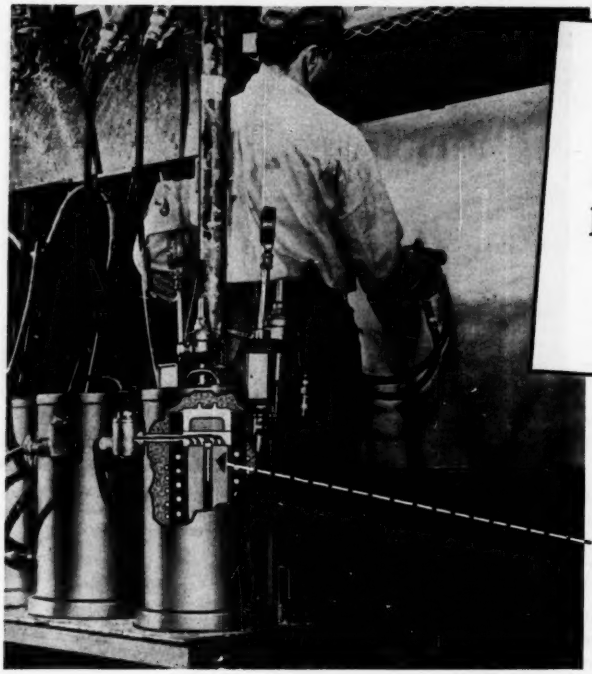
No. 125

FARVAL



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BEDE PAINT HEATERS, used to speed up paint spraying and save material by heating both paint and air, rely on Fenwal Block Head THERMOSWITCH Unit installed in explosion-proof heating block.

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A Fenwal THERMOSWITCH Unit — 8/10 of an inch in diameter — met all specifications: low cost, precise performance, compact size, high current-carrying capacity. By this, it enables Bede Paint Heaters to lower the cost of paint spraying throughout industry.

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Many types of control problems can be solved by easy-to-install, easy-to-maintain Fenwal THERMOSWITCH thermostats. Their activating control element is the single-metal shell that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts. Through this unique principle, THERMOSWITCH Units effectively control *many* variables where heat is a factor.

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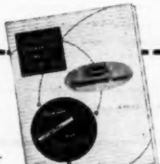
SENSITIVE . . . *but only to heat*



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- ☐ Alarm (over-temperature, under-temperature)
- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements)..........

....

....

New Boiler Code Rulings permit Higher Temperatures with INCO Nickel Alloys

A cleaned exchanger tube bundle being replaced in its shell. "Spring-cleaning" like this prevents failures in service and insures efficient heat exchange. *Photo courtesy The M. W. Kellogg Co., New York, N. Y.*

New interpretations of the A.S.M.E. Boiler Code have raised temperature limits on INCO Nickel Alloys used in the construction of unfired pressure vessels.

Also, in addition to annealed Monel, it is now permissible to use stress-relieved Monel, which has substantially higher mechanical properties.

These two modifications of the code mean that it is now possible to build stronger and lighter heat exchangers for higher temperature service, *that are insurable because they are built to code requirements.*

But this modified code applies only to physical properties. To overcome corrosion troubles, users must assume the responsibility for choosing the correct materials.

A glance at the table will show how some users have been able to get greatly increased equipment life by the proper choice of heat exchanger metals…

To see if INCO's Corrosion Engineering Service can help you, write, outlining your problem.

And at the same time, ask for a free copy of the new "Boiler Code Interpretations Involving Nickel, Monel, Inconel." It lists the new stress and temperature limits for the INCO Nickel Alloys.

OPERATING HISTORIES OF MONEL HEAT EXCHANGER TUBING

Case No.	Products Handled		Highest Temperature	Service Life		
	Inside tubes	Outside tubes		Previous Material	Monel tubes	Condition of Monel at last inspection
1	Steam	Caustic	350	2-8 weeks	17 months	Good—still in service
2	Foul Caustic	Steam	300	5 months	25 months	No evidence of corrosion
3	Heavy recycle	Straight run gasoline distillate	550	6665 hours	38,535 hours	Renewed 24 tubes after 22,000 hours—3 tubes plugged at 38,535 hours. Remainder OK.
4	Caustic soda and sodium chloride	Steam	240	10 months	80 months	Good—15 tubes replaced—weld failures
5	Crude oil	Gasoline vapor	300	6-8 months	48-60 months	No inspection

Service information on heat exchangers closely similar to yours is probably not in this table. However, help is available from INCO's Corrosion Engineering Service. From their thousands of data sheets showing corrosion rates in a wide variety of media, it is likely that an answer to your specific problem can be found.

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67 Wall Street, New York 5, N. Y.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 73 NUMBER 12

Contents for December, 1951

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Published monthly by The American Society of Mechanical Engineers. Publications office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents; to nonmembers one year $7.00, single copy 75 cents. Extra postage to countries not in the Pan-American Union, $1.50; to Canada, 75 cents. Changes of address must be received at Society headquarters four weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1951, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

Ira P. Macnab, President, The Engineering Institute of Canada, and J. Calvin Brown President, The American Society of Mechanical Engineers, Sign Agreement of Co-Operation Between the Two Societies, Oct. 26, 1951, at ASME Headquarters in New York

(*For text of the agreement see page 1034.*)

Volume 73
No. 12

MECHANICAL ENGINEERING

December
1951

GEORGE A. STETSON, *Editor*

The Founder Societies

IN these pages reference is frequently made to the "Founder Societies," a term which apparently is vaguely understood by many readers.

These Founder Societies are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The order in which these four society names are arranged follows seniority lines, based on the dates of organization, and is followed by the societies and by such groups as ECPD and EJC whenever occasion requires use of the four names together.

It was the creation by AIME, ASME, and AIEE of the United Engineering Society (now called United Engineering Trustees, Inc.) by act of the Legislature of the State of New York, signed by Governor Odell on May 11, 1904, and prompted by Andrew Carnegie's gift of one and one-half million dollars "for the erection of a suitable union home for you all in New York City," which gave to them the status of Founder Societies. The Founder Societies were allotted $1,050,000 and The Engineers' Club $450,000 of Mr. Carnegie's gift, and construction of The Engineering Societies Building, in West 39th St., and the Club on adjoining property in West 40th St., was begun. The Engineering Societies Building was dedicated April 15–20, 1907, with AIME, ASME, and AIEE as original tenants. ASCE, which had adequate quarters in West 57th St., became the fourth Founder Society, on Aug. 10, 1916, when three stories were added to the building for their occupancy. Toward the cost of this addition ASCE paid $262,500 and the other Founder Societies $12,500 each. The total cost of the land and building eventually amounted to $2,000,000 of which Mr. Carnegie gave $1,050,000 and the societies and other friends the remainder. Into the new building the societies also moved their libraries, maintaining them separately for a time. On Jan. 1, 1915, however, an agreement for a joint library, the Engineering Societies Library, was made and revised in 1916 to include ASCE.

Thus there was brought into being a project for a "union home for engineers" first proposed in 1887. The passage of time and the growth of membership of the Founder Societies have made the Engineering Societies Building inadequate as to size and outmoded as to most efficient and convenient use. Today, not one of the Founder Societies can hold the technical and social functions of their national meetings in their own home but must resort to a few of the larger convention hotels of the city. Two of these societies are forced to rent office space in other buildings. And the Engineering Societies Library yearly becomes more cramped for space. But the co-operative spirit which the "union home" symbolized has continued to grow and to draw the societies closer together in numerous joint activities, in many of which other national engineering societies have joined. Thus Engineers' Council for Professional Development and Engineers Joint Council include organizations that are not Founder Societies. And more recently this spirit of co-operation has taken on an international aspect, with close ties between ourselves and The Engineering Institute of Canada, the engineering societies of Great Britain and Western Europe, and those of South and Central America.

Erik Oberg

THE tragic death of Erik Oberg on October 22 ended a distinguished career which included numerous services to The American Society of Mechanical Engineers. For ten years he filled the post of Treasurer of the Society. His term of office began at the close of an era of economic expansion during which the Society grew in membership and committed itself to a program of activities and expenditures that could not be scaled down with sufficient rapidity to counteract the effects of the worst depression of the Society's history. They were disheartening years, particularly for the treasurer and other officers of the Society who saw assets dwindle in value, income shrink, and engineers unemployed and in distress. In these dark years the solid virtues of Erik Oberg were a very substantial bulwark of faith and fortitude.

Oberg was born and educated in Sweden. His first engagement in the United States was with the Cincinnati Milling Machine Company and the Pratt and Whitney Company, where he was employed as draftsman and designer. In 1906 he became an associate editor of *Machinery*. For forty-six years he served on the staff of that magazine; and when he resigned as editor in 1946, he became consulting editor and continued to visit the manufacturing establishments where he had been a familiar and respected figure since the early years of the century. Wherever metal was formed, Erik Oberg was known; and his work as editor not only of *Machinery* but of technical books, *Machinery's* Handbook, and *Machinery's* Encyclopedia benefited thousands.

In addition to acting as ASME treasurer, Oberg served on numerous important Society committees, and in both World Wars he found time to devote himself to the

interests of the United States government. In his fruitful life were exemplified to a high degree the benefits this nation reaps from the people of other lands to whom it opens the doors of opportunity.

An Engineer's Aim

IN AN American Newcomen address recently delivered in Boston, William F. Uhl, president, Charles T. Main, Inc., paid tribute to the founder of that firm of consulting engineers.

Charles T. Main will be remembered as a past-president and honorary member of The American Society of Mechanical Engineers and as an ASME Medalist, the highest honors the Society could confer on him. He himself founded the Charles T. Main Award of ASME to encourage young men. To the engineering world he was known for his contributions to hydraulics and steam and water power ("80 hydroelectric plants, large and small, have been designed by Mr. Main and his organization during the past forty-five years"); for his long association as a consulting engineer to textile mills; and for his pioneering studies and papers in the field of valuation.

But what persons who knew him admired most were the fine elements of his character, his industry, his integrity, his high ethical standards, his superior qualities as a good and useful citizen. They were the homely virtues of an old New England stock—hard work and honesty. Graduating from the Massachusetts Institute of Technology in the depression of the seventies, he managed to find a "good living and pay off the debts incurred during the last two years as a student" on a salary of $480, later $600, a year, as an assistant at M.I.T. On his first mill job the hours were 66 per week. Such were the rigors of life that produced men like Mr. Main.

It was in 1891 that Mr. Main decided to enter consulting practice and in 1893 he formed a partnership with F. W. Dean, an ASME member. It was again a "depression" year which he spent "in bringing notes of former work up to date and *preparing for business when it came*." Incorporation came in 1926 (he was then 70), and his active interest was maintained in the firm until his death at the age of 87. "He went to the office regularly until within two weeks of his death."

Of Mr. Main's business principles, Mr. Uhl said: "It was his idea that an engineering business should be entirely independent of outside influences and that none but active members of the organization should have any interest in it. A closed corporation is the result; and, as a member becomes inactive, he is obliged to relinquish all financial and other interests in the firm. As employees develop to the stage where they are believed to have the capacity for leadership and the ability to take on responsibility, they are given a financial interest in the business without any financial contribution on their part. In this way the responsible management is based solely on merit and capacity."

About a month before his death Mr. Main summarized his principles at a dinner given to his associates, which Mr. Uhl quoted:

"It should be the aim of the engineer to render the best possible service considered in a broad sense. It should be based on facts and not theories or suppositions, and upon scientific laws, which, if properly applied, will give satisfactory results. Nothing should be taken for granted, and the work or statements of others should be carefully checked before being adopted.

"The success of a man will depend upon his ability to produce results in an expeditious manner, which shall be accurate, and in which good judgment has been used, so that the finished product, if it be a physical structure, will be adapted to the use to which it is to be put and shall have been accomplished at a reasonable expenditure. If it be a plan for action, it shall be clear and concise and adaptable to the purpose for which it is intended.

"He should be able to understand men and to know them. He should be willing to share his knowledge with his fellow engineers, and inasmuch as he will do this through the society, or other similar means, his interests and outlook will broaden and the return to him will be multiplied.

"Integrity and perseverance in work and business, and fairness and justice to all will, in the long run, count for more than brilliancy in attainments. Withal, he must have a good stock of imagination and judgment, which is sometimes called 'horse sense,' in the application of fundamental principles to every day problems.

"The true success of a man is not measured by the accumulation of money, but by the success of accomplishment of work which adds something to the general good for mankind and for the advancement of the profession."

The young engineer of today faces economic and social conditions different from those under which Mr. Main lives, but the guiding principles of a satisfying and useful life are still the same.

Manpower Problems

EFFORTS to recruit the best-qualified young people to enter engineering schools are of public concern, particularly to employers who must continue to fill up their ranks in years to come in the face of a shortage of engineers. Organized guidance activities to this end are in progress throughout the nation, and what Engineers' Council for Professional Development is doing to support them and make them more effective is outlined in this issue by Willis F. Thompson, in an article, "Wanted—Engineers." Every engineer can help in this program.

The ECPD Training Committee is trying to finance a program of training graduate engineers. The greatest beneficiaries of this program will be the industries which depend on engineers. The amount needed is not great. One thousand dollars a year for five years contributed by a few employers will finance a program which will accelerate upgrading young engineers and ease the manpower shortage. Will you help?

Relating INDUSTRIAL RESEARCH *to the* COMPANY

By WALDO H. KLIEVER

DIRECTOR OF RESEARCH, MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, MINNEAPOLIS, MINN.

THERE is a mating problem in adapting research to its industrial partner which is as important to the success of the union as the choice of the right wife or husband is to matrimony. This morning we want to engage in a little match-making to determine some of the important factors in making the union a success. We start from the premise that, to be successful, ***the results of research must pay***. That has been said so many times that it sounds trite, and yet that simple statement is full of danger and often misunderstood. In their enthusiasm for insuring profitable research output, many people regiment their research to a point where it no longer performs its creative function. If we try to make each specific job pay for itself, if we try to predict exactly how each project will be carried out and what the results will be, then we are no longer doing research. The results will not be as profitable as they should be, due to the fact that we have tried to push for too immediate profits. Such research is often sold in the name of efficiency, and it must be admitted that sometimes for a limited period the output looks very attractive. However, it results in skimming the cream of scientific knowledge and soon it grows stagnant, both because it has not been built on a suitable foundation and also because such a program does not attract the most capable research people. The question of the balance between control and freedom in research and the related question of the balance between applied research and development on one hand and basic work on the other are among the most difficult and the most important problems in the administration of research. It is the purpose of this talk to start from the purpose for industrial research, which is new products, and better products, and lower costs, and to analyze the research techniques which will lead us most surely to these objectives.

THE COMPANY IS THE STARTING POINT OF RESEARCH

It is implied in the title that research needs to be adapted to particular companies, and that if companies are not all alike, neither are their research problems. The starting point should be the company itself. We begin by looking at the company's products; we look at the problems that are associated with those products, and at the opportunities that exist within the field in which the company is interested in doing business. This is ably described by Dr. Mees of Eastman Kodak, as follows: "What are the principles and objectives for the research program? I was asked that question a little while ago by a friend from England who wanted to know what I thought would be the objectives of commercial programs for industrial research in that country, and I said 'You can't generalize completely, but I will take any industry you like and tell you what its objectives should be. Will you take an industry?' He suggested, 'Well, let's take the boot and shoe trade.' I replied, 'Its objective should be better boots and shoes.' He said, 'That is a most astonishing statement. I have discussed that with people and they said that our objective should be new and better ways of tanning leather.' I stated, 'Of course that may enter into the making of better boots and shoes, but the objective of industrial research in the boot and shoe trade is better boots and shoes and unless you keep your eye firmly fixed on that you won't get what you are after.' He declared, 'I think that you should come over to England, not to preach science to the industrialists but to preach business to the scientists.' "

Another advocate of planning our research around the problem to be solved is Dr. Kettering. He states this as follows: "One of the fundamental courses that industrial researchers have to follow is to let the problem be the boss. We must not try to make it like something else. Petroleum is like petroleum, and it is going to stay that way and the progress is made when we swing around and play on petroleum's home lot. When poor Dr. Diesel made his engine 40 or 50 years ago, he had to put it in the place of a steam engine, so it had to be like a steam engine; and then when we came out with the automobile, the Diesels had to be like gasoline engines. All we did in our development work was to let them be like Diesel engines. So let these things be what they want to be. If I had to set up a forward-looking program for industrial research, I would say, 'Pick out the problem, pick out the best men you have, and then let the job be the boss from then on.' "

And so we start out with recognizing that companies are not alike and that therefore the research program that is best for one may not be ideal for another. Companies may be large or small, they may be new or old, they may be strong or poorly financed, they may have a high or a low overhead, they may be accustomed to research or unaccustomed to the idea, and what is probably most important, they will differ with respect to the products produced. For example, the products may be fabricated items or they may be processed materials; they may be simple or they may be elaborate; they may be competitive in the industry or may represent more nearly a monopoly. All of these factors must be taken into account in planning the research program.

This point was well illustrated at one of the round-table discussions of the Industrial Research Institute. There seemed to be considerable disagreement on some major issues. When the smoke cleared it finally turned out that different people were envisioning entirely different situations in research; some people were talking about the more basic kinds of research, some were talking about doing applied research on hard products such as many of us manufacture, and part of them were talking about quarter-million-dollar pilot plants for trying out ideas in chemical processing research. It was not surprising that we were not on common ground. This leads us directly to the question of what types of research we wish to apply to the company's problems and the techniques which are appropriate for these problems and these types of research.

WHAT IS RESEARCH?

The word "research" implies the use of the scientific method. The power of the scientific method has been ably demonstrated on many applications to problems. But the older techniques,

Contributed by the Management Division and presented at the Fall Meeting, Minneapolis, Minn., Sept. 26–28, 1951, of The American Society of Mechanical Engineers.

called the inventive approach, or common sense, or intuition, have also made a real contribution to our civilization. An article by Dr. W. F. G. Swann, director of the Bartol Research Foundation of The Franklin Institute, entitled "Engineering and Pure Science," published in the June, 1951, issue of *Physics Today*, treats this comparison in a very interesting manner. Dr. Swann begins with the story of the great European cathedrals. He admits that if he were given the job of building the great arches in these cathedrals he would probably apply a great deal of the theory of elasticity and go through extensive calculations of the stresses in the various parts of the structure. When he would finish, he admits with humiliation, he would probably turn to somebody with experience in the field and ask whether the answer looked logical and whether he felt the structure would stand. He goes on to compare the two approaches to the problem as follows: "In the development of modern technical industry, two partners are called upon to co-operate—practical experience and what is called scientific research. Experience is the product of six thousand years of civilization; science is the product of three hundred years, and in its relation to industry as a working partner it is a product of less than 50 years. It is therefore not remarkable that this healthy white-haired Methuselah, who is Experience, looks occasionally with suspicion at the energetic young upstart who is Science. Nor is it remarkable that the young upstart, looking back at his partner, regards him occasionally as a stubborn old fogey, hidebound in his ways and extolling continually the merits of horse sense. However, it has to be admitted that the old fogey seems fairly prosperous in spite of the ancient cut of his clothes; and, moreover, that he has much money in the bank which he has accumulated as the result of his methods and which—humiliating thought—provides in one way or the other much of the daily bread of the young scientist. How shall we appraise the relative merits of these partners? How can we plan for their most successful co-operation? How can we bring the old fellow to realize to the full the value which lies in what sometimes seem to be the high-falutin, impracticable activities of the youngster? Is there anything of value in those methods of horse sense, of cut and try, of long experience, which can be recommended to the youngster as things to be valued? And if so, how and in what form can we persuade the youngster to utilize this value? . . . . The fact is that the solution of a problem involves two parts: the fundamental laws which control all problems of the class studied, and the features (boundary conditions) which determine the particular case in which we are interested. Sometimes the contribution of the latter to features which interest us is simple, and the problem is one for exact solution by the theoretical physicist. Sometimes the said contribution is complicated, but important, and the solution becomes more the problem of him who applies approximate or even rule-of-thumb methods."

In some fields founded by scientific research, science has had its way from the start; and there is no longer much argument about techniques. Electronics is an example. More and more problems are being solved by scientific methods, and once the techniques for this are available, the older methods used alone are often left behind. However, we still hear arguments about the so-called "practical" as against the theoretical approach. The word practical in this sense is extremely distasteful, because we know that the theoretical method must be practical too if it is to be worth anything to us. However, it must be admitted by good scientists and research people that some of the criticism of the theoretical techniques is justified, as they are often used. We should not distinguish between the theoretical approach and the one which uses so-called common sense or horse sense, but instead ***we should make sure that common sense is also used in our theoretical approach to problems***. In this connection, there comes to mind a meeting with Dr. N. B. Nichols to discuss the use of the new REAC computer at the University of Minnesota with which he was then associated. He stated that the people who used analog computers successfully were also the people who had a fairly close notion of what answers to expect, before they ever put their problem into the REAC. In this way they not only checked the result but could study desired changes with a complete knowledge of the interpretations in terms of the practical problems being solved. Experience leads to the inevitable conclusion that the only really ***practical*** approach to research is the use of both experimental and theoretical techniques simultaneously, each helping to perfect the other as it progresses and leading to a more perfect understanding of the problem. Dr. Wickenden has said, "Theory without practice is tempted to lose its way in metaphysical futility, while practice without theory soon ends in sterility."

RESEARCH AND DESIGN

In our company research products go through the design engineering department before they go to methods engineering and production. There may be a development stage which may be either in research or in design. This separation has advantages based on different viewpoints of research and design people. The difference is expressed in a statement by Bichowsky in his book on "Industrial Research." He says, "The research man, if he is worth anything, must be able to find a grain of gold in a pan of gravel; a development engineer must be able to see the fly in the ointment. These attitudes—the one trained to look for what's wrong, the other to see the valuable features of a complete failure—make engineering and research complementary to each other, but also miles apart."

The separation of research from design does, however, bring about some problems which must be considered. It is never possible to put all the information learned in research on paper. Experience has shown that a close collaboration and follow-up is needed for a long time after the transfer of an item from research to design. However, during this period the research department will have to be tolerant of changes in the ideas and in the device. Designers are creative workers also and will contribute ideas of their own. If this is not permitted, life becomes uninteresting and unpleasant for them and you can't let that happen. Unless research people have good reasons to argue with designers that one of the design proposals will lead to trouble, such modifications should be allowed. In general, the changes will be for the better. Incorporating many people's ideas into a product seems to lead to the best end result.

HOW MUCH BASIC RESEARCH IN INDUSTRY?

How much effort should be put into basic research in industry? Sometimes we have to stick out our necks with regard to this question, and trust that an understanding management will be patient in looking for results. The real gravy in the long run is in basic research. This problem usually solves itself at our place by our starting a problem in applied research. In looking for new answers we soon run out of textbooks and need more information to make intelligent decisions. If the indicated basic research looks promising, and especially if several projects lead to the same basic field, a project is instituted. The laboratory thus tends, as it grows older and more mature, to go farther toward the basic side of research.

But whether we do or do not do basic research in our own laboratories, it is very important that we appreciate the importance of basic research to our industry and to our country. The need has become generally recognized, and it is very gratifying to see that a great deal is being done to insure a cradle for basic knowledge. Much of this will be done at

universities and some at their research institutes. I am told that most of the projects at these institutes are sponsored by companies which have research organizations of their own. Dr. Vannevar Bush emphasizes this thesis further in his book, "Science and the Endless Frontier," when he says, "Basic research leads to new knowledge. It provides scientific capital. It creates the fund fromw hich the practical application of knowledge must be drawn. New products and new processes do not appear full grown. They are founded on new principles and new conceptions which in turn are painstakingly developed by research in the purest realms of science. Today it is clearer than ever that basic research is the pacemaker of technological progress." Dr. Frederick Hovde, president of Purdue, emphasizes the importance of basic research when he says, "My closing thesis is that the universities are 'the goose that lays the golden eggs' of knowledge, while industrial laboratories make the omelet of application for public consumption. If there are no eggs there can be no omelet. It would be a tragic national mistake if industry and government together failed to invest in the production of new knowledge and the development of the nation's individual talent. Such a course would indicate a woeful lack of understanding of what makes our system of free enterprise tick."

CO-OPERATION WITH THE UNIVERSITIES

Since basic research is so important, what can we do about this problem? Well, I think there is a great deal which industry can do to encourage basic research, even when it cannot undertake such research in its own laboratories. Industrial firms can be active in sponsoring such work in universities, in research institutes, and in trade associations of their own. This can be done indirectly or directly as through fellowships at the universities. We have six fellowships in engineering at the University of Minnesota, and we feel that they have been very successful in fulfilling the objectives set up for them.

One condition is very important when industry sponsors research in universities. It is possible for such an industry to try to direct the research too closely from the standpoint of its own peculiar problems. As soon as we do that we not only are failing to help basic research, we actually are interfering with the source of basic knowledge. Research in a university must have as its objective, not the development of products which we happen to manufacture, but rather observation and determination of new facts and new knowledge about the universe. It must be on that basis that we support it. I am much pleased that our management has agreed with me on this point. I was gently chastised on this point some time ago by our executive vice-president while we were discussing these fellowships, and he said, "What are you trying to do? We want these fellowships to be on a broad basis and to be of general benefit to mankind, and we do not want to direct them into our particular line of manufacturing." I explained to him that we also had felt that way about it and that we had allowed the university and the appointed fellows to do basic research with the freedom which is necessary for that purpose. At the same time we felt that it was the responsibility of those of us who were in the research department of the company to watch this research and to see where the results could be applied. In that way we did not limit the basic research at the university but at the same time we did derive benefits for the sponsor from this research. Not the least of these benefits is the close, friendly relationship with the university and the opportunity to get acquainted with good students.

RESEARCH SERVICES

In solving the company's problems, research often finds itself called upon for help of the kind that I will term "research services." We must continuously find a balance between such short-range projects and the longer-range creative research. If research does none of the immediate problems, it will find that many of its research products from the longer-range projects do not get as early an outlet.

Under research services are considered trouble-shooting or correction of product difficulties, both in the field and in manufacturing. These services are very important; they not only help to solve important company problems, but they also benefit the research department by supplying firsthand knowledge of the company's problems. I will not take time to note examples since, undoubtedly, each of you can recall examples from your own experience.

One other research service that should be mentioned is the practice of calling on research to supply expert personnel for other positions in the company. A number of people have been transferred just recently from our own research department to important positions in our company. Not only are capable research people well-suited for many positions in the company that involve systematic planning, but they also understand the problems and new products of research and can be helpful in fostering new ideas through the company. In deciding on these transfers, two items were considered in particular: (1) the opportunity for the individual to progress, and (2) the position in the company in which the man could serve the company to best advantage. I know that this policy is not unique with our company. Mr. Art Hyde, vice-president in charge of research at General Mills, tells me that he makes a regular practice of training people for transfer to other departments, and he believes that it is one of the very important contributions of research to his company. The following statement by W. A. Myers, assistant manager of research and development for the Atlantic Refining Company, serves as an example of this philosophy: "We have followed a policy of hiring in the research department practically all of the young technical people for the company."

However, a research division must not let itself get wound up entirely with such research service work. Important as it is, the most important responsibility of the research department is still creative research, and it must lead in new ideas for solving the company's problems. There will usually be no shortage of ideas for longer-range research projects. The new ideas may come from the customer, from sales, from management, or from the engineering design department. The research department serves as an origin for many new ideas on products; if it has some imagination it will apply to the company's problems many by-product ideas resulting from work on other projects.

WHO SHOULD SELECT RESEARCH PROJECTS?

While the broad fields of research will usually be related to company objectives and defined by top management, the research department should have a voice in selecting the projects undertaken to solve the problems in these fields, and especially should be in charge of detailed planning of the work. This is confirmed by experience in many research organizations. Dr. Furnas expresses this as follows: "Research is always new, and the detailed planning and execution can be carried out properly only by the person or organization which is responsible for the results." Dr. Mees, of Eastman Kodak, states this with considerable emphasis as follows: "The best person to decide what research work should be done is the man doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director, who is probably wrong more than half the time. Then comes a committee, which is wrong most of the time. Finally there is the

committee of company vice-presidents, which is wrong all the time."

IMPORTANCE OF A GOOD RESEARCH STAFF

In the final section we want to consider some of the important points of internal management of the research department which make it an efficient tool for solving the company's problems. By far the most important of these is that of capable and co-operative research workers. Nothing takes the place of this, and without it the research administration can work its heart out and still not obtain desired results. With capable people, the administration of research becomes to a great extent a matter of giving these people the necessary facilities and the necessary freedom to work out their own answers. Westbrook Steele, of the Institute of Paper Chemistry, has said, "While industries compete in services and products, their ultimate competition is for manpower."

One phase of this problem of staffing your laboratory with capable people is that of getting good supervisors. These will usually be people who are appointed after they have had some experience with the company and have accepted some of the philosophies which fit into the particular research organization. It probably will be of interest to this group to review the results of a questionnaire sent to leaders in research. The questionnaire was sent by the Standard Oil Company of Indiana to 160 people in 80 companies, principally chemical, with 85 per cent returns. The results give us the following picture of a leader in research. His age is probably over 40 years. His background is in proportion of one chemist, one physicist, and three mechanical or electrical engineers. He attributes his success to both technical and executive ability. Forty-two people had teaching experience, seventy had no teaching, few of them had over one or two years. Sixty-two per cent of them reached supervisory jobs within five years after graduation. The time taken to double their salaries was two to seven years. (A similar survey by the American Chemical Society of 20,000 chemists gave 13 years.) He does not change jobs often; 40 per cent had worked for only one company, and 30 per cent for only two companies; 50 per cent of them had 1 to 5 patents, 50 per cent more than 5. Forty-five per cent of them had no publications at all; most of them make few speeches; fifty per cent have studied public speaking. Of the nontechnical courses, the most emphasized was English, the second economics. Ninety per cent paid some of their own school expenses, 40 per cent did not belong to any civic or welfare organization. However, one thing that was outstanding about them was that most of them habitually work after hours and many of them quite often.

ATMOSPHERE FAVORABLE TO FREEDOM OF THOUGHT

Probably the next most important factor in a research organization after the selection of good people is the atmosphere of research which encourages freedom of thought. In general, the rule is that the more basic the research the more freedom is necessary.

There is much authority for this, and I should like again to quote a few opinions here. Henry Grady Weaver in his book, "Mainsprings," says, "Free minds are inventive minds. That is why America has always been a land of inventors." Dr. Vannevar Bush says, "Scientific progress on a broad front results from the free play of free intellects working on subjects of their own choice in the manner dictated by their curiosity for exploration of the unknown." Frank Jewett, Sr., says, "All productive science, both fundamental and applied, is essentially creative. It is the result of the operation of men's minds and it flowers most profusely in an atmosphere of maximum freedom. No man or group of men can predict in advance what will come out of other men's minds. . . . The most that they can do is to provide a favorable environment for creative effort . . . Because the methods which science uses, both fundamental and applied, are so powerful and certain in achieving the ends sought, money spent through well-organized research and development departments is the least risky and potentially the most profitable of all the expenditures in which industry ventures capital." Dr. Mees expresses this thought powerfully as follows: "No director who is any good ever really directs any research. What he does is protect the research men from the people who want to direct them and who don't know anything about it."

MOTIVATION OF RESEARCH

Closely associated with this subject of a proper research atmosphere is that of motivation. This is a big subject and one that I hope to treat in a complete paper some time before long. Essentially, however, it involves treating people so that they will have an interest in their work and think of the company's problems as their problems. The most important factors in achieving this result are based on treating people as individuals and letting them know that management is interested in their work and cares about the progress that they make in their projects and in their growth in the company. These factors are consistently rated higher than that of pay by the people themselves, although of course if pay is allowed to sag far out of line that would be evidence of lack of interest in the welfare of the people. These principles can be followed while maintaining high standards for the work.

GOOD COMMUNICATIONS ESSENTIAL

A fourth point of internal management also associated with personnel phases of this subject is that of good communication. This has several angles; it involves a free exchange of ideas between the research people themselves. Any one of them having a problem should automatically go to someone else in the laboratory who is an authority on that particular subject. Also, it involves an exchange of ideas between the research people and the development and engineering groups, and includes the writing of thorough reports.

Other phases of internal management include the problems of budget control, the keeping of good records, writing of reports, security with regard to the information. We cannot take the time to elaborate on these here, but want to say that they should be organized so that they involve the least disturbance possible of the individual research worker in his research activities.

SELLING THE PRODUCTS OF RESEARCH

The sixth point under internal management is that of selling the products of research. This is a very large subject in itself and one that I have treated in a previous paper given at the Electronics Conference and published in *Electronics* magazine for December, 1948. It is extremely important that the research department recognize the need for making the results of their research available to the departments in the company who can make use of it. It is easy for the research man to feel, especially when he is new at the game, that when he has done a good job at making new information available his work is completed. However, the other people in the company are busy with their own problems and perhaps subject to some inertia. Even top management, who must be interested in research because they are willing to pay for it, still have the right to question new ideas and to require proof that they are economically sound. The research people and the supervision must be responsible for interpreting research results in the lan-

(*Continued on page 988*)

NEW PRECISION BAROMETER *and* BAROGRAPH

By C. A. HEILAND

HEILAND RESEARCH CORPORATION, DENVER, COLO.

A NUMBER of noteworthy attempts have been made in recent years to increase the precision and, at the same time, portability of barometers to make them suitable for accurate determinations of terrain elevations. For this purpose, three varieties of barometer appear promising: The mercury barometer, the gas barometer, and the aneroid. Probably the least promising of these is the mercury barometer as it is too fragile and cumbersome in the field. Though widely used, the aneroid, even the precision aneroid, is subject to the effects of friction and elastic hysteresis which limit its accuracy to about 0.1 T.[1] In the search for a new principle of measuring barometric pressure, much research has been devoted recently to the use of the air as an ideally elastic body in place of the metallic diaphragm of the aneroid by determining, for example, the change required in the volume of an isothermal chamber to balance it against another chamber of atmospheric pressure. However, this principle is subject to serious limitations because of the great dependency of a gas upon temperature, making it necessary to provide thermostatic control which in turn increases the weight and operational difficulties in the use of such a device in the field. Further, it is necessary to control the temperature with an accuracy of 0.004 C in order to obtain an accuracy of 0.01 T. A gas barometer for geophysical elevation measurements has been described recently by A. A. Stripling, R. A. Broding, and E. S. Wilhelm.[2]

The present paper describes a precision aneroid barometer having an accuracy of 10 milli-T and a range of 500–600 T, which has been developed by Dr. Anton Graf in co-operation with W. Olbrich and F. Haalck, and is being built by the Askania-Werke in Berlin. Technical data and illustrative material for the following article were made available to the author through the courtesy of Dr. Graf.

FEATURES OF MICRO-BAROMETER

The new instrument will be referred to briefly herein as a Micro-Barometer. Its main features, bringing about an increase in accuracy over the conventional precision aneroid by as much as one power of 10, are a helical Bourdon tube in place of a metallic capsule, and the use of optical in place of mechanical amplification of the deflection. Other features of this instrument include low tilt-sensitivity, obviating the necessity of leveling; low temperature sensitivity, making thermostatic control unnecessary; and low weight (8 lb) and small dimensions ($11 \times 6^3/_4 \times 4^1/_2$ in.).

CONSTRUCTIONAL DETAILS

Fig. 1 shows outside views and Fig. 2 a sectional view of the Micro-Barometer. The Bourdon tube, 1, consisting of 9 turns, is fastened with its upper end to the torsion head, 2. The lower end is attached to a disk, 3, carrying a tubular extension of approximately the same length as the Bourdon tube. At the upper end of the tube, and below the disk, this structure is attached to a stabilization wire, 4, terminating above in the torsion head, and below in the bottom part of the airtight tubular housing, 23 (clamps 5 and 6). The purpose of the stabilization wire is to act as the axis of rotation for the spring and to reduce the tilt-sensitivity of the instrument. An extension of the disk, 3, carries a mirror, 8, whose function it is to transmit the rotational motions of the spring to the reading attachment. The reading device is in essence an autocollimational system consisting of an objective lens, 16, in the focus of which is a scale, 14. This scale may be illuminated from the outside by the mirror, 30, reflecting light through the window, 12, to the prism, 13, whence it passes vertically downward by way of the prism, 15, to the objective lens, 16, and from there through the window, 17, to the mirror, 8. The mirror, 8, returns the light by the same path and produces an image of one of four indexes upon the scale, 14 (see section, Reading Arrangement). The scale and the indexes moving thereon may be seen in enlarged dimensions through the eyepiece, 19. The high degree of magnification made possible by the autocollimational system would limit the range of this instrument if provision were not made to extend it. This is done by attaching a second scale, 22, to the top of the torsion head which may be rotated by turning the knob, 20, attached to the end of the micrometer screw, 21. The oscillations of the moving system are damped by the piston, 9, which moves in a vessel filled with a suitable liquid. The damping achieved by this means is so effective that it is pos-

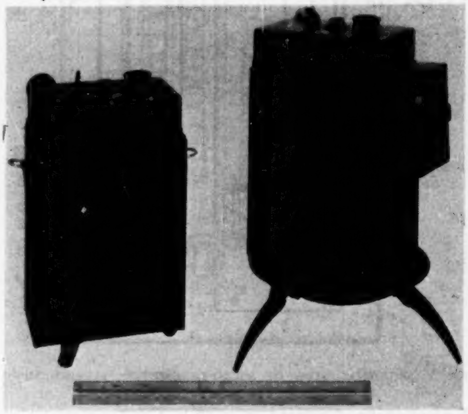

FIG. 1 VIEWS OF MICRO-BAROMETER

[1] 1 T = 1 Torr = 1 mm Hg = 1.333 kilodynes cm^{-2} = 1.333 millibars.

Contributed by the Industrial Instruments and Regulators Division and presented at the Joint Conference, Houston, Texas, September 10–14, 1951, of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers and the Instrument Society of America.

[2] "Elevation Surveying by Precision Barometric Means," *Geophysics*, October, 1949, pp. 543–557.

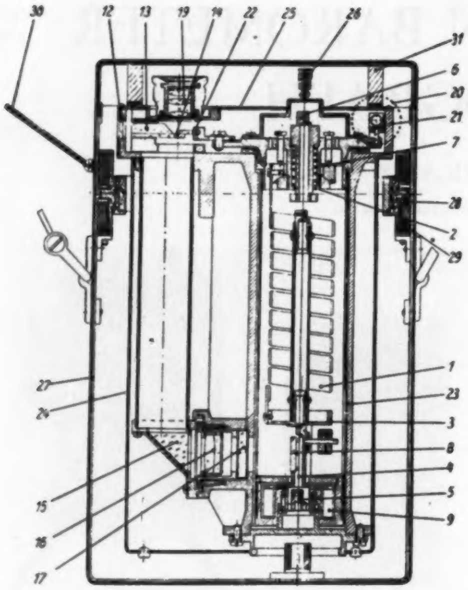

FIG. 2 SECTIONAL VIEW OF MICRO-BAROMETER—FLUID-DAMPED MODEL

(1, Bourdon helix; 2, torsion head; 3, disk; 4, torsion wire stabilizer; 5, 6, clamps; 7, coil spring; 8, mirror; 9, damping ring; 12, window; 13, illumination prism; 14, scale and index plate; 15, prism; 16, objective lens; 17, window; 19, eyepiece; 20, micrometer knob; 21, micrometer screw; 22, range scale plate; 23, inner housing; 24, container; 25, top plate; 26, orifice; 27, outer case; 28, 29, gimbals supports; 30, mirror.)

sible to read the instrument when held by hand provided the operator leans on a suitable support. It is more convenient, however, to set the instrument on the ground or upon a tripod, in which case an electromagnetic damping arrangement is preferable. For the liquid damping, about 30 sec are required for the instrument to come to rest; for the electromagnetic damping, about 2 sec. In order to make it unnecessary for the instrument to be leveled, the working parts are suspended in a gimbals suspension, the outer ring of which is visible in the figure, the supports being indicated by the numerals 28 and 29.

Outside air is admitted through the orifice, 26. It is not necessary to clamp or unclamp the instrument. The instrument is essentially temperature-compensated by partially filling the Bourbon tube with dry air of a few cm Hg pressure.

READING ARRANGEMENT

The reading arrangement and the provisions for increasing the range of the instrument are shown in Fig. 3. This figure indicates schematically the Bourdon tube *a*, its lower termination in the mirror *g*, and its upper termination on the torsion head, with a projection *b*, engaged by the micrometer screw *i*, operated by the knob *c*. On the other side of the projection, the torsion head carries an arm with a circular scale segment *b*, which is viewed through the eyepiece, as is the scale *e*. The fixed scale has 100 divisions, each division corresponding to about 0.1 T so that 0.01 T may be estimated. While the extent of the fixed scale is thus 10 Torr, that of the range scale with 30 divisions is about 500 T. The index plate not only carries one, but four indexes, one of which may appear in the field of vision of the eyepiece indicated by the letter *f* and by crosshatching in Fig. 3. The distance apart of these indexes is 100 scale divisions, and they are designated as 0, + 100, + 200, and + 300, whereby the direct-reading range (without the use of the range adjustment) is increased from 100 scale divisions to 400 scale divisions (about 40 T).

Usually the range is adjusted to cover pressures from some 300 to 900 T or elevations from — 3300 to + 23,000 feet, making possible uses in deep mines, on high mountains, and aircraft as well.

RECORDING MICRO-BAROGRAPH

Fig. 4 shows the adaptation of the Micro-Barometer to con-

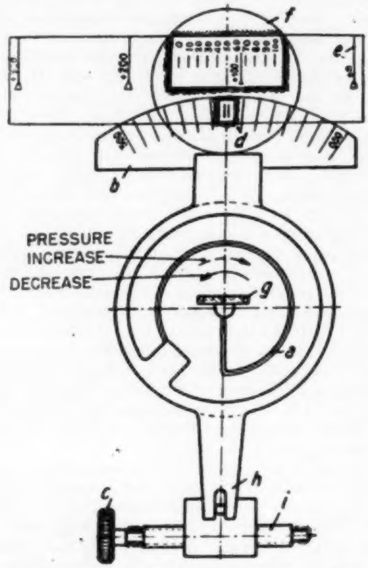

FIG. 3 DEFLECTION AND RANGE SCALES; RANGE ADJUSTMENT

[*a*, helix; *b*, range scale; *c*, micrometer knob; *d*, index brackets; *e*, scale and index plate (deflection scale); *f*, field; *g*, mirror; *h*, fork; *i*, micrometer screw.]

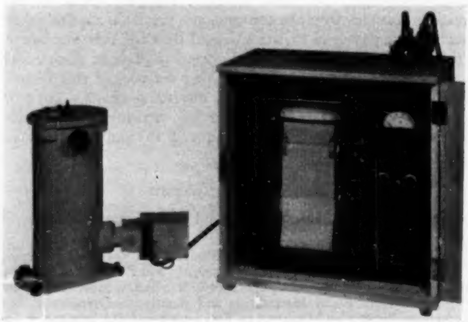

FIG. 4 MICRO-BAROGRAPH WITH DIFFERENTIAL PHOTOCELL ATTACHMENT

tinuous recording by the use of a photoelectric recording attachment currently in use with Askania magnetometers. The attachment contains a light source projecting a beam of light directly upon the mirror 8, indicated in Fig. 2, whence it is reflected to a differential photoelectric cell which may be connected to a recording microammeter. The sensitivity of the Micro-Barograph may be adjusted so that a deflection of the recording microammeter of 0.1 mm to 1 mm corresponds to 0.01 T.

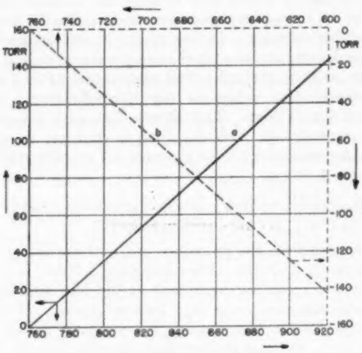

FIG. 5 CALIBRATION OF RANGE SCALE
(*a*, range from 760 to 920 Torr; *b*, range from 600 to 760 Torr.)

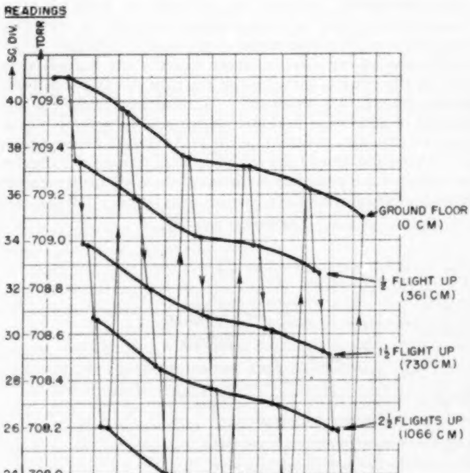

FIG. 6 OBSERVATIONS WITH MICRO-BAROMETER IN STAIRCASE

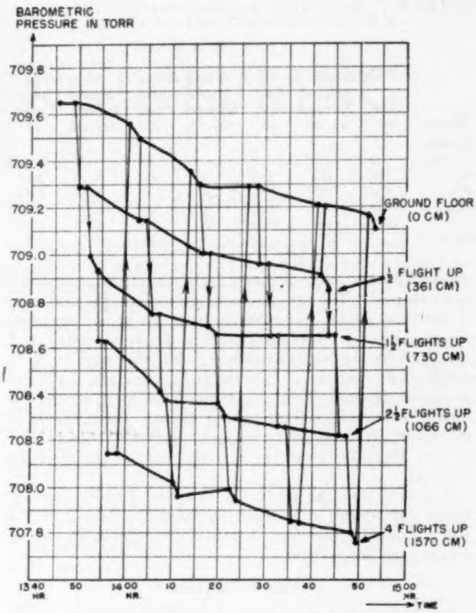

FIG. 7 OBSERVATIONS WITH ANEROID BAROMETER IN STAIRCASE

CALIBRATION

The relation between the barometric pressure and the reading is linear for both instruments. Fig. 5 illustrates the results of a calibration of the visual instrument in the ranges from 600 to 760 T, and from 760 to 920 T. The instrument may also be readily calibrated in terms of elevation differences, and its sensitivity and accuracy be demonstrated by measurements in different elevations, for example on different floors of a building. To the geophysicist this procedure is familiar from the calibration procedures of gravimeters.[8] The results of the calibration of a Micro-Barometer are indicated in Fig. 6. In Fig. 7 results of measurements with a conventional precision aneroid are shown for comparison. The measurements were started on the ground floor, two readings being taken; they were then continued, likewise with two readings, on the next half floor, being 361 cm above the ground floor; were then followed by measurements at 730 cm elevation at the floor No. $1^1/_2$, next at 1066 cm elevation at the floor No. $2^1/_2$, and ended with two readings at the fourth floor at 1570 cm elevation (about $51^1/_2$ ft). The successive times corresponding to the observations at these elevations are indicated in the diagram. Next, the observer descended and took another set of readings at the ground floor, as well as on the four additional floors above it, which showed a uniform drop in all the readings corresponding to the daily variation in atmospheric pressure which had taken place in the meantime. Altogether, each elevation was measured five times. The same procedure was followed by simultaneously observing an aneroid barometer (Fig. 7).

The results of these observations and comparisons are listed in Table 1 which shows for the four different levels, the actual elevation as determined by tape measurements, the elevation

[8] "Geophysical Exploration," by C. A. Heiland, Prentice-Hall, Inc., New York, N. Y., 1940, p. 135.

TABLE 1 COMPARISON OF MICRO-BAROMETER AND ANEROID OBSERVATIONS IN STAIRCASE

	Elevation by			Error of mean (of 5 observations)		Error of single observation	
Floor	Tape, cm	Micro-Barometer, cm	Aneroid, cm	Micro-Barometer, cm	Aneroid, cm	Micro-Barometer, cm	Aneroid, cm
Ground floor	0	0	0	..	..	..	..
1/2	361	368	377	7	16	± 9	±27
1 1/2	730	736	722	6	8	±11	±64
2 1/2	1066	1070	1140	5	74	± 3	±71
4	1570	1560	1600	10	30	± 6	±28
Mean	..	..	..	8	48	± 9	±60

measured by the Micro-Barometer, and the elevation measured by an aneroid. The next two columns indicate the deviations of the mean of five observations from the actual elevations measured by tape. It is seen that these deviations were 7, 6, 5, and 10 cm for the Micro-Barometer, while they were 16, 8, 74, and 30 cm for the aneroid. In the mean, therefore, the Micro-Barometer determined the elevations within 8 cm, whereas the aneroid determined it within about 48 cm. The remainder of the tabulation shows the mean error of individual observations for the Micro-Barometer as ± 9 cm, and for the aneroid as ± 60 cm.

It is seen that the maximum elevation difference of 15.7 meters corresponds to a mean barometric difference of 1.43 Torr. Roughly, therefore, 1 milli-T corresponds to a difference in elevation of 1 cm.

TERRAIN MEASUREMENTS

Fig. 8 shows the application of the Micro-Barometer to the measurement of a difference in the elevation of a valley station V, and a hill station H, together with the results of a series of measurements made with a precision aneroid. In order to eliminate the temporal variation of air pressure, the two stations were occupied alternately whereby one of the stations, say, V, would be considered as the base. This procedure, therefore, is similar to that applied in magnetometer measurements where a base station is likewise occupied between field measurements, except that in that case the diurnal variations are usually smoother and generally smaller in magnitude than the anomalies measured at the field station. Therefore, for measurements of this kind, it is preferable to determine the temporal variations of the atmospheric pressure with a continuously recording instrument. However, in the measurements here referred to no such instrument was available, and the base and field stations were occupied alternately a number of times. It is seen from the diagrams that the field station was occupied with both aneroid and Micro-Barometer seven times, and the base station eight times. The two V and H curves are moved together in an amount of 1.95 Torr in order to make a comparison more readily possible. It is seen that the aneroid curves are much more irregular, which is not due to error in the atmospheric pressure but to instrumental errors. This becomes quite evident by comparison of the aneroid curves with the Micro-Barometer curves which may be expected to record the time variation of atmospheric pressure more faithfully because of their greater accuracy. In any event, the maximum error in elevation determination with the aneroid is seen to be 0.24 Torr with an error of the individual observation of ± 0.11 Torr. The corresponding values for the Micro-Barometer are 0.04 Torr and ± 0.02 Torr. This shows that with a repeat base station measurement with the same instrument, an elevation may be determined with an accuracy of approximately ± 20 cm (about ± 8 in.).

FIELD PROCEDURES TO INCREASE ACCURACY OF BAROMETRIC ELEVATION MEASUREMENTS

As stated before, the procedure just outlined is not particularly accurate and too time-consuming. Next in order of accuracy is a recording barograph at the base station with a field barometer occupying field stations nearby. By contrast with magnetometer observations, it is necessary in this application to move the base station more often because of the horizontal variation and the time variations of barometric pressure.

Of equal accuracy is probably the use of two simultaneously read field instruments, successive stations being occupied in the well-known leapfrog manner.

The procedures referred to require two instruments. With three instruments, however, the accuracy can probably be at least doubled. Two of these instruments would be recording Barographs at two base stations of a known difference in elevation and known distance apart whereby the horizontal as well as the vertical variations of the time variations of barometric pressure are obtainable. A third instrument (or any number of additional field instruments read by separate operators) are then used to determine the field values of the elevations in between and around the recording base stations. A further extension of this procedure is the use of three Micro-Barographs in an equilateral triangle (tripartite arrangement). When used

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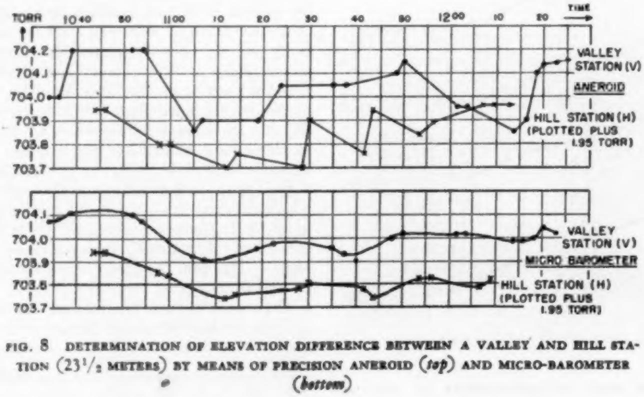


FIG. 8 DETERMINATION OF ELEVATION DIFFERENCE BETWEEN A VALLEY AND HILL STATION ($23^1/_2$ METERS) BY MEANS OF PRECISION ANEROID (*top*) AND MICRO-BAROMETER (*bottom*)

SHORT CUTS *in* PILOT-PLANT ENGINEERING

By J. S. REARICK

DEVELOPMENT ENGINEER, THE M. W. KELLOGG COMPANY, NEW YORK, N. Y. MEMBER ASME

THE petroleum industry has had a leading role in the development of continuous-process pilot plants, and these in turn have contributed in no small measure to advances in refining technology. The two major fields of pilot-plant utility are development of new processes and evaluation of the effect of changes on existing processes. In the former category, pilot plants are used to bridge the gap between laboratory and plant, to determine the effect of operating variables, and to obtain engineering data necessary for the design of full-scale units. Where the process is already in commercial operation, the pilot plant makes it possible to study the effect of changes in feed stocks, and operating conditions, or to predict the result of equipment modifications at reduced cost and without loss of production on the process unit. Where a new plant must be built for a known process, the pilot plant will furnish the design information necessary to adapt the process to the feed stock or other conditions peculiar to the specific job.

To be useful for any of these purposes it is essential that the results obtained from the operation of the pilot plant be representative of the performance of the full-scale unit. This particularly is true in the case of the engineering contractor who may be required to guarantee the performance of a commercial plant on the basis of such data. Consequently, the pilot plant must be engineered carefully both from a process and from a mechanical standpoint. Since practically all of the elements of the large plant may be found in the pilot unit, engineering costs become excessive if carried out in the same detail as for a full-scale installation. It is the purpose of this paper to describe some engineering "short cuts" which have proved successful in holding such costs to a minimum.

PROCESS DESIGN

Although this discussion is concerned primarily with mechanical design, the process design is closely related and merits brief consideration in this connection.

There are numerous differences between the design of pilot and full-scale units. In general, the commercial plant is designed to operate at a specific capacity on a specific feed stock and to produce specific products of specific quality. The pilot plant, on the other hand, must be designed to operate over a wide range of conditions on a variety of feeds; capacity per se is of little importance; and economy of heat or utilities does not generally have to be considered. For an existing process the range of conditions will be fairly well established, but for a new process, the designer is usually working in unknown territory, guided only by more or less sketchy laboratory data. Frequently he must transpose batch data to continuous operation, predict the effect of recycling, and make similar extrapolations.

Regardless of the purpose of the pilot plant, it is highly desirable first to attempt to visualize the full-scale plant and then to scale the latter down to the pilot size. Although at first glance this might seem to be a reverse procedure in the case of a new process, it is actually not, since the function of the pilot plant is to predict the operation of a full-scale unit, and failure to consider the latter in the design may result in a pilot unit which will not produce data applicable to any larger scale.

Pilot-plant design inevitably involves some degree of compromise inasmuch as it is impossible to scale up or down without some change in relationships. It is the joint responsibility of the process and mechanical designers to insure that such changes do not impair the validity of the data produced.

The importance of the application of principles of similitude to pilot-plant design has been pointed out frequently in the past. Unfortunately, however, the relative importance of the various factors affecting the process under consideration usually has not been established firmly, and generally it is not feasible to adopt the devices which have been proposed to achieve similitude where more than one physical process is controlling.

The problem is further complicated by the fact that scale factors of several thousand to one are not unusual. Therefore the designer must make a thorough study of the available data for the particular process and attempt to estimate the relative

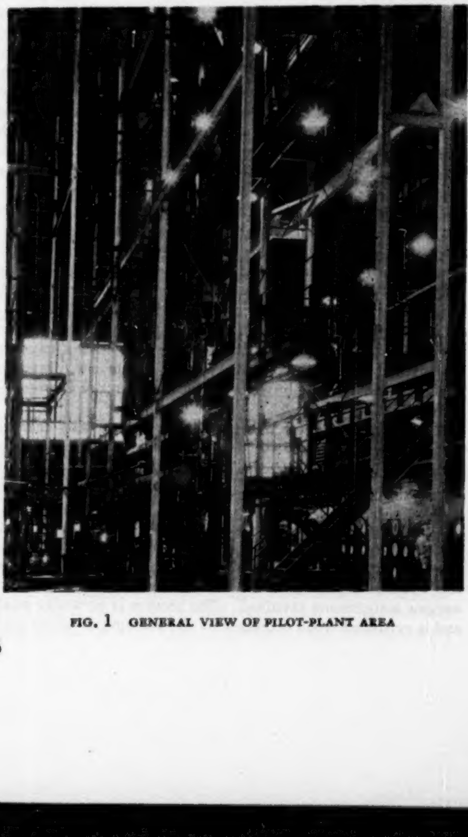


FIG. 1 GENERAL VIEW OF PILOT-PLANT AREA

Presented at the Petroleum Mechanical Engineering Conference, Tulsa, Okla., September 24-26, 1951, of The American Society of Mechanical Engineers.

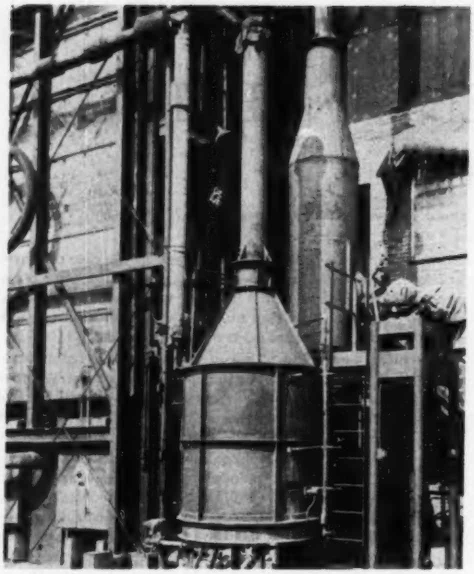


FIG. 2 STANDARD HELICAL-COIL FURNACE

importance of the physical and chemical factors affecting it. In this phase of the design it is of the utmost importance that there be close co-operation between the process and mechanical designers in order that the process requirements will be met in a mechanically feasible design.

ORGANIZATION

A major factor in the success or failure of a pilot-plant program is the skill and thoroughness employed in the mechanical design of the unit. Pilot-plant operations are costly and much time and money may be lost as a result of mechanical inadequacies of the equipment. Here again compromise is necessary to produce a satisfactory plant at a reasonable engineering cost. The guiding principles which were used in attacking this problem might be expressed as continuity, co-ordination, and standardization. By assigning one individual to each project to follow it from the initial stages of design to final completion of construction, much of the lost motion involved in relaying information was eliminated; by close co-ordination between process design, fabrication, and construction personnel the amount of detail required was greatly reduced; by developing standard designs and details for certain types of equipment, drawings could be used repeatedly with, at the most, minor changes or additions.

It was found desirable to set up a group specifically charged with the responsibility for designing and constructing pilot plants. It consists of three major sections; design, mechanical, and machine and instrument, all reporting to the laboratory engineer.

The members of the design section are preferably graduate engineers with an aptitude for this type of work who have had previous experience in pilot-plant operation. They must possess a rather high degree of versatility in order to handle the various assignments involved. The section is normally small and is expanded when necessary by the addition of junior men, usually drawn from other sections of the laboratory. It is responsible for all design work and also furnishes general and facilities engineering services to the laboratory as a whole.

The mechanical section is responsible for all maintenance and construction work within the laboratory, including fabrication of special equipment. It is headed by the mechanical supervisor under whom are the various craft foremen and mechanics. Many of these men also have had prior experience in the operating group. The size of this section is subject to considerable variation depending on the work load, but by maintaining a nucleus of thoroughly trained men, considerable expansion is possible without serious loss in efficiency. When the size of the group is at a minimum, the craft foremen become working foremen; when at a maximum, their duties are entirely supervisory.

The machine and instrument section handles calibration, maintenance and repair of all instruments, and such machine work as is carried out within the laboratory organization. It is also custodian of various items of equipment salvaged from dismantled pilot plants and reconditioned for future use.

OPERATING PROCEDURE

The operation of the system can best be illustrated by following the course of the design and construction of a pilot plant and pointing out some of the short cuts employed. When it appears desirable, based on preliminary laboratory work, to carry the development into the pilot-plant stage, the design section is brought into the project.

The design engineer to whom the project is assigned is the key man from the first preliminary rough estimate of plant cost until the pilot plant is in successful operation. He participates actively in establishing the process design, carries through all phases of mechanical design, serves as adviser to the mechanical section during fabrication and construction, and provides technical assistance within his field during initial operations.

As the first step, a tentative process design is established through consultation with the research personnel concerned with the previous laboratory work, and the minimum mechanical design work necessary to prepare an approximate estimate is carried out. The amount of such work done at this stage will depend on the accuracy desired in the estimate of plant cost, but generally it is quite limited.

After approval of the project, a final process design is agreed

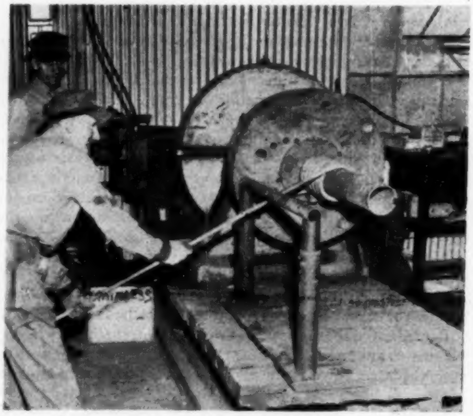


FIG. 3 COIL-WINDING MACHINE

upon through the joint efforts of the research and design personnel. This sets forth the range of operating conditions, heat duties, and capacities; it also includes the dimensions of the major vessels and a general outline of the control scheme to be employed.

The design engineer under the supervision of the head of the design group is completely responsible for all phases of the mechanical design of the plant. In the case of a large project he may have one or more junior engineers assigned to assist him. After the process design has been approved, a detailed flowsheet is prepared showing schematically all process lines, equipment, and instrumentation. Utility lines generally are not shown, except for points of connection to the equipment. Where the scope of the job requires it, a separate utility diagram may be prepared. The flowsheet is the most important drawing and serves as key to the entire job. As the design progresses, additional information such as line, equipment, and instrument designations, and so forth, is added to it. It is of great value to the operating personnel prior to and during the start-up of the new plant, and a copy is usually mounted permanently at the site. The designations shown on the flowsheet are also placed on metal tags permanently attached to the valves on the plant for ease of identification.

From the flowsheet a list of required equipment is assembled. Any equipment available in storage is checked for suitability, and specifications are prepared for that which must be purchased. A rough material take-off is made based on the flowsheet plus previous experience with other plants, and the necessary requisitions are issued. It is the practice to maintain a reasonable stock of commonly used materials which serves to balance out any inaccuracies in the take-off.

A plot plan and an elevation drawing showing locations of all principal pieces of equipment are next prepared. The first issue of these is of a preliminary nature for guidance in the detailed design of the various vessels and equipment; as such designs are completed, the plot plan and elevation are finalized for use in the erection of the equipment.

The layout of the plant is simplified by the arrangement of the pilot-plant area. The principal area occupies a space 60 × 200 ft with a maximum headroom of approximately 56 ft. Utility mains are carried around the inside of the boundaries of the area with connections provided at 20-ft intervals. These include cooling water and return, 100-psi steam, 100-psi air, fuel gas, and 1000-psi N_2. A three-phase power bus encircles the area in a similar manner. The reinforced-concrete floor is designed to support any anticipated loads and is sloped slightly to transverse drainage trenches at 40-ft intervals.

An attempt has been made to standardize on the design of major structural work in the pilot-plant area with an eye to permanent utility, even though the pilot plants themselves may become obsolete. This design provides considerable flexibility to accommodate vessels of various dimensions, includes the necessary stairs and walkways for convenient access to the equipment, and is used wherever practicable.

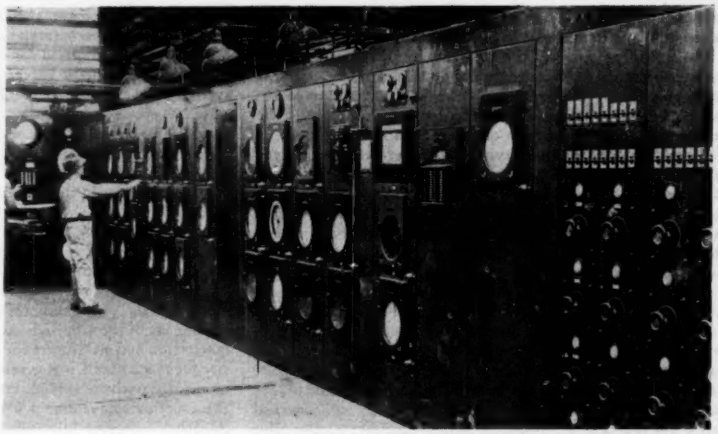


FIG. 4 FACE OF TYPICAL CONTROL BOARD

FABRICATED EQUIPMENT

Numerous short cuts are employed in the design of equipment to be fabricated, many of which are possible because of the close liaison that exists between the design and mechanical sections and the experience of the latter in this type of work. Drawings of equipment are prepared in far less detail than would be necessary for an outside vendor. Liberal use is made of symbols and standard details. These include drawings for certain frequently used types of equipment which require only the addition of a few dimensions and other details before release for fabrication. For example, electrically heated lead pots are commonly used for heating small streams to relatively high temperatures. Standard designs have been prepared for these as well as for helical-coil gas-fired heaters to handle larger quantities. Standard designs also have been prepared for various sizes of coil-type coolers. Methods and equipment developed by the mechanical section have facilitated and reduced greatly the cost of winding the coils for such purposes.

PIPING SYSTEM

Although there are instances where accurate sizing of piping is necessary, generally it is not required, and it has been advantageous to use $^1/_2$-in. Sch 80 (extra heavy) seamless pipe with 3000-psi forged valves and fittings for all process lines wherever possible. At first glance this might seem extravagant, since in many cases cheaper materials or a smaller size would be adequate for the service. Piping materials, however, represent a small part of the cost of the unit, and it is felt that the saving in engineering time and simplification of purchasing and stockroom operations more than offset the increase in cost. The use of $^1/_2$ in. as the minimum size has the additional advantage of providing greater rigidity and strength, as well as facilitating application of heaters and insulation. Where lines will carry light hydrocarbons or gases under pressure, it is standard practice to seal-weld, braze, or silver-solder all threaded joints. Wherever practical, unions are provided to permit dismantling various sections of the equipment.

Standard specifications have been set up for the various utility lines in accordance with the service. For instrument connections $^1/_4$-in-OD steel tubing with compression fittings has been found satisfactory with copper tubing and brass fittings used for

instrument airlines. Standard details have been prepared for various piping arrangements which are encountered frequently.

The flowsheet provides the basis for installation of piping without necessity for detailed piping drawings. This again, is made possible by the extremely close liaison maintained between the design engineer and the construction force. The decisions as to exact location of the various lines are made on the spot. It goes without saying that experience in this type of work on the part of the construction crew is a great asset. However, the same mode of operation has been employed successfully in erection of pilot plants at other locations with field labor. The advantage of having an engineer on the site who is thoroughly familiar with all aspects of the design cannot be overemphasized.

ELECTRIC HEATERS

Because of its high surface-to-volume ratio, small-scale equipment operated at elevated temperatures requires compensation for heat lost by radiation. In many cases this can be accomplished most satisfactorily by the use of electric-resistance heaters. As a result a considerable amount of electrical work not found in the full-scale unit is necessary in the pilot unit. To minimize the design work required in this connection, standard methods of application have been developed to meet various requirements. In addition, standard heaters of several types and capacities have been adopted; these are capable of taking full line voltage.

It is the usual practice to provide a variable transformer to control each heater. For the sake of uniformity a single size of variable transformer is used, and all standard heaters are designed to match its capacity. Where the requirements exceed the capacity of a single heater in any area, two or more parallel heaters are employed with a variable transformer on one and line switches on the others.

The method just described eliminates the necessity for exact calculation of heat requirements and permits the use of a single size of conductor, circuit breaker, and autotransformer; it provides great flexibility for future modifications.

The number, type, and locations of the heaters are generally indicated on the vessel drawings or, in the case of piping, on the flowsheet. The controls are located on unit panels of the type described subsequently, and drilling templates and wiring jigs are used to reduce fabrication time.

CONTROL BOARD

A standard panel size has been adopted for the control and instrument board, and a design for the framing of the board has been developed which permits panels to be interchanged readily. The frame is continuous and is located just inside the limits of the pilot-plant area with sufficient space behind it to permit convenient access, with doors at intervals for this purpose. This arrangement provides a great deal of flexibility to meet changed requirements that may develop during the operation of the plant and aids in maintaining a neat appearance.

Standard layouts have been prepared for various combinations of commonly used instruments and other control equipment. The electric panels carry their own terminal strips and bus bars so that they can be removed or replaced readily. The only drawing that must be made in many cases is a simple elevation sketch of the board indicating the location of the instruments and controls and the standard layout applying to each panel.

INSTRUMENTATION

As mentioned previously, the control diagram and instrument designations are shown on the flowsheet. The locations of the individual instruments appear on the control-board sketch. In addition, an instrument list is prepared showing under the appropriate designation, the make, type, range, control characteristics, and other information pertinent to each instrument. A similar list is prepared for the various control valves. Because suitable control valves for pilot-plant work were not available some years ago, a $^1/_4$-in. valve was developed. This valve has proved very satisfactory in a variety of services over a considerable period of time and might be described as a single-seated, modified chisel-plug valve. Four sizes of interchangeable trim give a wide range of capacity and charts have been prepared to assist in the selection of the proper size.

CONCLUSION

Both design and construction of pilot-plant equipment call for specialized techniques, and the development of a closely integrated group to handle such work offers many advantages. Centralization of the responsibility for all phases of the design and the use of the same individual to follow and co-ordinate the fabrication and erection of the equipment, eliminates the necessity for much detail. Standard details and designs can be used repeatedly with consequent saving in engineering cost. While these methods have been developed in an organization engaged in rather extensive pilot-plant work, some of them, at least, also should be helpful in more limited operations.

It hardly needs to be said that the successful operation of the system described depends on the caliber of the men who make up the organization, and a real desire to co-operate on the part of all concerned. With such assets it has been possible to build a large number of pilot plants with engineering costs on the order of 10 to 15 per cent of the total.

ACKNOWLEDGMENT

The author wishes to acknowledge the many contributions of his associates and express his gratitude to the M. W. Kellogg Company for permission to publish the information contained herein.

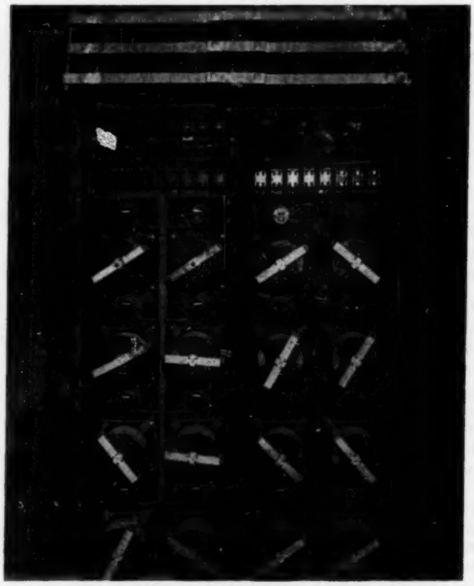


FIG. 5 REAR OF ELECTRIC PANELS

PHYSICAL *and* MECHANICAL PROPERTIES *of* CAST IRON

By W. LEIGHTON COLLINS

PROFESSOR OF THEORETICAL AND APPLIED MECHANICS, UNIVERSITY OF ILLINOIS, URBANA, ILL.

Introduction

THIS discussion of the physical and mechanical properties of cast iron is primarily based upon the information of such properties presented in a booklet "Engineering Properties of Cast Iron," by the American Foundrymen's Society in 1950.[1] The booklet was prepared for and intended to be used by the design engineer. The committee of eleven outstanding foundry metallurgists who reviewed the original presentations of W. O. Mahin,[2] and H. W. Lownie, Jr.,[3] and who were responsible for the sponsorship and development of the booklet had the sincere hope that this concise authoritative accumulation of the latest data on gray cast iron would aid the engineer in improving his designs, as well as in making a wiser selection of the best material for the intended use.

It is not the objective of this paper to repeat the numerical values, graphs, charts, or comparisons with other materials presented in the booklet; if that is desired, reference should be made to the booklet itself. Instead, a way of thinking for an engineer designing a load-resisting member will be suggested, and the portion of the booklet dealing with physical and mechanical properties will be outlined. Also a few of the mechanical properties will be discussed from the point of view of our present knowledge and of the needed knowledge if the use of the wide variety of cast irons now available is to be extended into fields which may now be considered somewhat unusual, but for which a particular cast iron may be well suited. It is not to be inferred that this procedure indicates any omission or incomplete effort on behalf of the original authors, the reviewing committee, or the publishing organization; all have done a good job and a needed job, and all should be complimented for their achievement.

HOW A MACHINE DESIGN IS EXECUTED

Now, what is the thinking of a design engineer as he proceeds from his original concepts of the load-resisting member to the final dimensioned machine or structural part? His thinking may be divided into four steps, particularly when he does not have a code or specification to guide him.

The steps, perhaps oversimplified or idealized, are as follows:

1 Determine how the material of which the member is made will fail if the load becomes great enough to cause failure; i.e., cause the member to fail to function as intended in the design. That means guarding against the type of failure feared most and determining the significant action in the material that leads to failure. Offhand, that may not seem too difficult for gray cast iron, a brittle material. However, when all possible conditions of use of gray cast iron are considered—static or repeated loads; operating temperatures that may be elevated, room, or subzero; surrounding media that may be more or less corrosive; limitations on the amount of elastic or inelastic deformation; and the state of stress, uni-, bi-, or tri-axial—the determination of the significant action in the material that leads to failure of the member may become rather difficult. It is probably safe to say that gray cast iron is used under most of the foregoing combinations of conditions and, apparently, used satisfactorily.

2 Determine the property of the material that is associated with the action significant in failure and the relation of the property to the load. The property so selected becomes the measure of the maximum usable strength of the material and limits the load-carrying capacity of the member. The significant property would be the tensile strength if the member fails in tension, the endurance limit if failure is due to a very large number of repeated loads, the creep limit or "growth" for prolonged exposure at elevated temperatures, or one of the many other properties of materials if that one happens to be significant in the failure. The relation between this maximum usable strength and the load is usually expressed as an equation and involves the dimensions of the member.

3 Determine by appropriate test the numerical value of the property determined in step 2. This is basically a laboratory procedure in which good testing techniques should be used and in which the action significant in the development of failure in service must be simulated, in order that the failure under test will be the same as that which occurs in service. Other properties of the material that may be useful in carrying out step 4 also may be determined.

4 Select the working or safe value of the quantity significant in failure and determined by experiment in step 3. This involves the selection of the so-called factor of safety, a selection which necessarily must be based on sound judgment and experience, as well as on test data. For example, the tensile strength may be divided by 5 or 10 to get the working stress; other properties, where significant, would be treated in a similar manner. Then the appropriate formula from step 2 that expresses the relation between the load, the significant property and the dimensions of the member is used to proportion the member properly.

If these steps are followed and if, in step 3, the material selected is found to have a high value of the property particularly desired (along with a good combination of melting, molding, and other desirable characteristics), the design will be both efficient and economical. Thus the choice of the proper material is an indirect part of step 3 and is an important problem the designer must solve. Only through the recognition of the merits of a material and its application can the material be used most effectively or have its use extended to broader fields of application.

[1] "Engineering Properties of Cast Iron," published by American Foundrymen's Society, 616 S. Michigan Ave., Chicago 5, Ill., where the booklet may be purchased.

[2] Director of Research, Armour Research Foundation, Chicago, Ill.

[3] Assistant Supervisor, Battelle Memorial Institute, Columbus, Ohio.

Contributed by the Metals Engineering Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of The American Society of Mechanical Engineers.

PRESENTATION OF DESIGN DATA

Any information intended to be in a form readily available and of practical use to the design engineer should fit into the design procedure just outlined. If reliable test values of the property judged to be significant in the proposed use are available for a variety of materials, the designer does not have to perform step 3, the determination by test of the magnitude of the property associated with failure; he can and does base his choice of material and maximum usable value of the property on published data. The authoritative accumulation of the latest data on gray cast iron contained in the booklet[1] serves this need of the designer. The data are presented in as brief a form as possible in order to make the booklet most useful, but keeping the size down has meant, in turn, that many data of a specific nature had to be omitted. Reference should be made to "Cast Metals Handbook,"[4] for a more complete compendium of properties.

The following twenty-four physical and mechanical properties are discussed in the booklet:

Effect or thickness	Castability
Tensile strength	Machinability
Compressive strength	Wear resistance
Yield strength	Corrosion resistance
Modulus of elasticity in tension	Electrical conductivity
	Coefficient of thermal expansion
Endurance limit	Thermal conductivity
Impact strength	Magnetic characteristics
Plastic elongation	Specific gravity
Hardness	Oxidation resistance
Transverse strength	Tensile strength at elevated temperatures
Resilience	
Damping capacity	Creep at elevated temperatures

The space devoted to each property is about one page and the arrangement of the information on each property usually follows a regular pattern which, as can be judged from the reproduction of a typical discussion, Fig. 1, is:

1 A bar graph indicating numerical values of the property for various classes of gray cast irons (usually at least Classes 20, 40, and 60), and all or some of the following materials: a heat-treated gray cast iron, an alloy cast iron, white cast iron, normalized cast steel and malleable iron, Grade 35018.

2 Test methods—the property is defined and appropriate references are made to the specifications of the American Society for Testing Materials.

3 Relative value of cast iron—a general statement is usually made regarding the range of the value and a comparison is made with the values for other ferrous products.

4 General engineering cast irons—the way in which the value varies with tensile strength or some other pertinent variable is usually stated.

5 Special cast irons—the trend in values resulting from alloying or heat-treatment is mentioned.

Also of use to the designer are three tables, in one of which are tabulated the numerical values for most of the properties already enumerated. The table is outstanding because it is not often that such a wide range of properties can be found for a given cast iron. Ten materials are included in this table, six of which are gray cast irons, as cast; the properties of two of these irons are also given for heat-treatments for high hardness and for high strength; one of these two irons also has the properties tabulated for the fully annealed state.

The second table on properties is a long one, 27 pages. It deals with the use of alloy cast irons and, as can be judged from the typical page shown in Fig. 2, lists specific applications, chemical compositions, metal-section range, weight range, Brinell hardness, transverse load, transverse deflection, tensile strength, and brief remarks about the use—such as whether it is for wear or heat resistance, high strength, high density, corrosion resistance, uniformity of structure, and so forth. The value of such information to the designer of cast-iron parts as an aid in the selection of materials cannot be underestimated.

The third table is entitled "Suggested Analyses of Cast Iron Based on Strength and Section." This also is of value in the selection of the proper cast iron for a given use. The chemical range in per cent, average carbon equivalent, metal section range in inches, Brinell hardness, transverse load in pounds, strength deflection in inches, and tensile strength in pounds per square inch are tabulated for light, medium, and heavy sections of seven classes of cast irons varying from Class 20 to Class 60.

DESIGN OF LOAD-RESISTING MEMBER

Space does not permit discussion of the information presented for each of the twenty-four properties. Consequently, as previously stated, emphasis will be placed only upon some of the properties that are involved with the design of a load-resisting member, and the point of view will be the consideration of our knowledge of the properties when the engineer attempts to

3. COMPRESSIVE STRENGTH

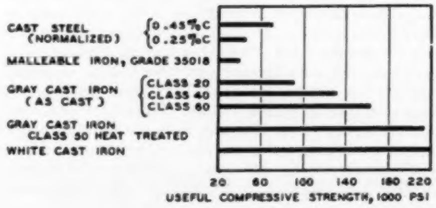


Fig. 9. Useful Compressive Strength
(1/2 to 1 inch casting wall thickness)

a. Test Methods - Compressive strength refers to the maximum stress that a material will withstand in compression without failure. Cast iron and some other materials exhibit a definite compressive strength, as failure occurs by actual fracturing. Steel, malleable iron and other ductile metals do not fracture in compression but begin to deform plastically when the elastic limit is exceeded. The usual compressive strength of such ductile metals may be defined as that stress beyond which the amount of deformation renders the part unfit for service. In most applications, the useful compressive strength of ductile metals will approximate the yield strength in tension.

Standard procedures for the compression testing of metals are contained in Specification E 39-33T of the American Society for Testing Materials. A specific method for compression testing cast iron is contained in ASTM Specification A 256-42T.

b. Relative Value of Cast Iron - One of the most valuable commercial properties of cast iron is its high strength in compression. The compressive strength of even a relatively soft gray cast iron will equal the useful compressive strength of a cast steel with a tensile strength of 100,000 psi and will have two to three times the useful compressive strength of malleable iron. The compressive strength of white cast iron is of the order of 220,000 psi.

c. General Engineering Cast Irons - The compressive strength of gray cast iron varies from three to five times its tensile strength. Class 20 cast iron exhibits compressive strengths of the order of 90,000 psi. High strength gray cast irons have compressive strengths up to and sometimes exceeding 200,000 psi.

d. Special Cast Irons - Since compressive strength increases with tensile strength, the compressive strength of cast iron may be improved by the same procedures used to increase tensile strength.

FIG. 1 REPRODUCTION OF A TYPICAL DISCUSSION
(From "Engineering Properties of Cast Iron.[1]")

[4] Published by the American Foundrymen's Society.

SPECIFIC APPLICATIONS OF ALLOY CAST IRON

TYPE	Chemical Range, Per Cent: Si	TC	GC	CC	S	P	Mn	Ni	Mo	Cr	Other Elements	Metal Section Range, in.	Weight Range, lb.	Hardness Brinell	Transverse: Load, lb.	Defl., in.	Tensile Strength, psi	Remarks
COMPRESSORS and PUMPS—Cont.																		
Pump Impeller, Sand and Copper Mill Tailings	0.30 to 0.40	3.60 to 3.90			0.09 to 0.12	0.15 to 0.25	0.80 to 0.95	4.25 to 4.75		1.40 to 1.60		2 to 4	2500 to 4000	*(70)				Used for wear and abrasion resistance.
Pump Impeller, Sand Dredges, Hydraulic	1.15 to 1.25	3.00 to 3.10			0.08 to 0.10	0.12 to 0.16	0.85 to 0.90	1.40 to 1.45		0.50 to 0.60		2 to 5	12,000		2600 to 2700(2)	0.3	44,000 to 46,000	Used for wear resistance.
Pump Shell, Sand and Copper Mill Tailings	0.30 to 0.40	3.60 to 3.90			0.09 to 0.12	0.15 to 0.25	0.80 to 0.95	4.25 to 4.75		1.40 to 1.60		2 to 4	7000 to 9000	*(70)				Used for wear resistance.
Pump Shell, Face Plate, Sand and Mill Tailings	0.35 to 0.45	3.70 to 3.90			0.10 to 0.12	0.15 to 0.25	0.30 to 0.50	4.50 to 4.75		1.40 to 1.60		1 to 1½	500 to 1500	*(68)				Used for abrasion resistance.
Pumps, Well Drilling, High Pressure (5000 psi	1.20 to 1.40	2.90 to 3.10	2.10 to 2.20	0.70 to 1.00	0.09 to 0.12	0.04 to 0.06	0.80 to 1.00	0.90 to 1.10	0.60 to 0.80	0.40 to 0.60		2 to 6	4000 to 16,000	269 to 293(41)			58,000 to 60,700	Used for high strength and density at machinable hardness.
Pumps, Oil Well Drilling	0.80 to 1.00	2.90 to 3.10	2.10 to 2.30	0.80 to 1.00	0.10 to 0.13	0.15 to 0.19	0.70 to 0.80	1.90 to 2.10	0.30 to 0.50	none		2 to 6	7000 to 10,000	290 to 320			48,000 to 54,000	Used for density and pressure resistance. Pumps must pass pressure test of 5,000 psi for 30 minutes.
Pump Liners, Used in Sludge Pumps	1.20 to 1.40	2.90 to 3.10	2.20 to 2.40	0.60 to 0.80	0.10 to 0.13	0.12 to 0.16	0.70 to 0.80	none	0.45 to 0.55	none		1 to 2	200 to 700	235 to 255	4800 to 5300(4)		46,000 to 53,000	Used for density, high strength and wear resistance properties.
CRUSHING and GRINDING EQUIPMENT and ABRASION RESISTING CASTINGS																		
Crusher Frames, Gyratory and Jaw Type Crushers	1.50 to 2.00	2.70 to 3.00			0.10 max.	0.20 max.	0.60 to 0.80	1.00 to 2.00		0.00		1 to 3	6000 to 40,000	220 to 260	6000 to 6500(4)	0.17 to 0.20	50,000 to 60,000	Used for strength, rigidity, and machinability. Used to replace steel castings.
Jaw Crusher Plates, Crushing Ore, Gravel, Stone	0.40 to 0.50	3.20 to 3.40	0.00	3.20 to 3.40	0.08 to 0.10	0.15 to 0.18	0.50 to 0.60	4.40 to 4.60		1.40 to 1.60		2 to 4	200 to 1500	*(43)	4500 to 6000(4)	0.06 to 0.08	35,000 (43a) to 50,000	Used for resistance to wear, abrasion, and for toughness. In lead and zinc ore above type of "Ni-Hard" plates have given service of 450,000 tons as compared to 225,000 tons for manganese steel in same service.

FIG. 2 TYPICAL PAGE FROM SPECIFIC APPLICATIONS OF ALLOY CAST IRONS
(From "Engineering Properties of Cast Iron.[1]")

follow the suggested design procedure not only for the routine cases but also for some of the more unusual service conditions.

Tensile Strength. Gray cast irons can be obtained with tensile strengths of from 25,000 psi to 95,000 psi. Comparison with other cast ferrous products reveals that only cast steel has a tensile strength exceeding this upper limit of 95,000 psi. Tensile strength, however, varies with wall thickness; a part cast with a wall thickness of 0.5 in. may have a tensile strength of about 57,000 psi whereas the same iron in a casting with a wall thickness of 1.5 in. would be expected to have a tensile strength of only 38,000 psi at the center of the section. It is possible, however, to get a tensile strength of 57,000 psi for wall thicknesses of 1.5 in. It can be accomplished by changing composition or heat-treatment or by a modification of foundry practice; the cooling rate of the casting does affect the tensile strength. The higher-strength irons are usually used for the thicker wall sections; for example, a Class 20 iron for a thickness of $^1/_8$ in. to $^3/_4$ in. and a Class 60 iron for $^1/_2$ in. to 4 in. All of this presents a very useful and fairly complete concept of tensile strength, but castings used in service almost always have some relatively abrupt changes in shape that may be called "stress raisers" and at which there are high localized stresses. For ordinary gray cast iron, subjected to a static load axially applied, these localized stresses are high enough to reduce slightly the magnitude of the load that could be supported by a similarly loaded unnotched bar of the same area. It is only reasonable for the designer to wonder about the magnitude of such an effect for irons of other strengths, heat-treatments, and compositions. The answer to this important question of behavior apparently is still to be determined.

Yield Strength. Yield strength in tension for an offset of 0.2 per cent is another commonly determined property for many materials. For gray cast irons the yield strength is generally about 85 per cent of the tensile strength, but, because its value is so near the tensile strength, it is not usually determined or specified. Several thoughts arise about the significance of this property of gray cast iron. It cannot be considered to be a measure of failure resulting from excessive plastic deformation as for a ductile material without a yield point, and it is of limited value in estimating the shape of the stress-strain curve, along with modulus of elasticity, ultimate strength, and maximum elongation. The merit of its determination probably is for purposes of comparison with cast steel and malleable iron, materials for which yield strength at 0.2 per cent offset may be significant because it is on the order of about 60 to 70 per cent of the tensile strength. It would seem though that a more useful concept of the behavior of the material under load would be obtained if the offset were smaller, perhaps 0.05 per cent. The designer also may want to know something about such a property in compression or torsion, but for such types of loads data apparently are not plentiful.

Modulus of Elasticity. The modulus of elasticity is a property that must be used when stiffness or the amount of elastic deformation governs the design. Although the modulus of elasticity of steels has a constant value of about 29,000,000 psi, the value for cast iron increases with the as-cast tensile strength, being about 10,000,000 psi for a Class 20 iron and about 21,-

000,000 psi for a Class 60 iron. However, even for a given iron, there is no absolute value of the modulus of elasticity as it changes with section size, the chemical analysis, and the magnitude of the stress. Some specific data for values in tension and compression and their relation to the relative values obtained from transverse tests are given in the "Cast Metals Handbook,"[4] but comprehensive results for a variety of irons or for torsion tests are rare. Exactly how to determine a useful and reproducible value of the modulus of elasticity of a material for which the stress-strain diagram is curved from the origin is another perplexing problem.

Endurance Limit. The endurance limit of gray cast iron is a property that is becoming more and more significant as the number of types of irons and the obtainable range in values of properties are increased. Average values indicate that the endurance limit increases with the tensile strength, the ratio of endurance limit to tensile strength usually being about 0.5 for Class 20, 40, and 60 irons in the as-cast condition; but for cast iron, cast steel, and malleable iron, the endurance limit for smooth unnotched bars may be from about 35 to 50 per cent of the tensile strength. The types of cast irons and the conditions under which the low percentage of 35 could be expected should be known to the designer; that he would want to know whether the ratio is 0.35 or 0.50 for the iron he proposes to use can be appreciated readily when step 4 of the proposed design procedure, selection of a working stress, is considered. The effect of a notch on the endurance limit of a material is also important to the designer; few parts, as actually made and used, are free of abrupt changes of shape and the consequent stress concentrations which are so significant in the behavior of a material subjected to repeated loading. Gray cast iron, however, suffers much less drastically from the effect of a notch than theory indicates and also much less than most other metals. The endurance limit for notched specimens, just as for unnotched, increases with as-cast tensile strength, but not in the same proportion; a Class 20 cast iron may have a notched endurance limit of about 50 per cent of the tensile strength, whereas a Class 60 cast iron may have a notched endurance limit of about 35 per cent of the tensile strength.

Specific information on the endurance limit is given in the booklet[1] in the table of typical properties; the endurance limits for unnotched and notched specimens are tabulated for six cast irons, including those which have been heat-treated. If the strength-reduction factor, ratio of endurance limit for unnotched specimens to the endurance limit for notched specimens is computed for the data presented, the values vary from about 1.1 for the as-cast Class 20 cast iron to about 1.3 for the as-cast Class 60 cast iron. The data for heat-treatment to high hardness and high strength indicate that the factor is greater, in each case, than for the as-cast condition of the material. These data are all very valuable, but the study of fatigue is a big problem and for all metals introduces many questions, such as the effect of range of stress, type of stress, combinations of stresses, corrosion, temperature, size of specimen, size of casting, residual stresses, type of iron, heat-treatment, and so forth. Particularly is this true for the cast irons alloyed and heat-treated for high strength, because they are most apt to be used for load-resisting members where design for load-carrying capacity is the governing criterion. Information on some of these questions is in the "Cast Metals Handbook,"[4] but, when the large number of types of cast irons is considered, our present knowledge is meager.

Elevated Temperature. Under such a heading would come topics such as oxidation resistance, growth, short-time tensile strength, stress-rupture tests, relaxation testing, and creep. Few creep tests have been made on cast iron but according to the booklet, "At about 660 F commercial gray cast irons can resist stresses of about 10,000 psi and exhibit creep of less than one per cent in 10,000 hr. This resistance to creep is approximately equal to that of low-carbon cast steel under the same conditions."

The very limited knowledge of the creep behavior, stress-rupture behavior, or relaxation behavior of cast irons of various types and strengths hardly can be considered adequate for a clear understanding of the behavior of the material. Many cast irons are made specifically for high-temperature use, and the question arises as to whether their more widespread use is limited by a lack of knowledge of the behavior under the conditions just mentioned.

Our knowledge of properties of materials and their study should not necessarily follow satisfactory service; at times, at least, the study should precede the use. Progress, however, is being made in the use of cast iron at elevated temperatures; the American Society for Testing Materials now has a specification, "A278-49 T, Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650° F," and this Society has a special committee which has about completed preparation of a new part, UCI, for the revised Section VIII of the Boiler Code. The latter is based upon the specification of the American Society for Testing Materials. It should also be added, as another sign of progress, that the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals now has plans to initiate a study of cast iron.

A discussion of elevated-temperature use also brings up the question of the use of gray cast iron at subzero temperatures, and its behavior under such conditions. The use is reasonably apparent, but data for the designer appear to be almost nonexistent.

CONCLUSION

From the consideration of these few properties it may be concluded that despite the many years of use of gray cast irons under a wide variety of conditions, we still do not know as much about the behaviors of cast irons under load as we should; extensive studies apparently have been relatively infrequent. This becomes striking when one thinks of the much newer material, aluminum and its alloys, and data on these in the publication, "Structural Metal Aircraft Elements."[5]

There have been widely different motivating influences back of the development and use of these two materials, and the problems of production and control of product are widely different. Nevertheless, it can be said that the aluminum alloys have been studied very systematically and extensively, and much money has been expended on the studies.

Gray cast iron, today, by virtue of its wide range of properties, justifiably can be considered an important engineering material, and its efficient and economical use depends upon proper consideration by the designer of its wide range of properties. It does seem, though, that for gray cast iron to reach its maximum use as an engineering material in a broadening field of applications, systematic long-range programs of study that involve considerable expenditures of time and money should be undertaken and the results widely disseminated to the engineering profession.

Everyone interested in cast iron has one more question to ask, namely, what is said in the booklet about ductile or nodular cast iron? The answer unfortunately is "nothing," for the booklet was prepared before this newest of cast irons came into use. This new ductile iron widens the possibilities of the engineering use of cast iron, and any comment made about the knowledge of physical and mechanical properties of other types of cast irons would apply equally well, or more so, to ductile iron.

[5] Publication ANC5a of the Munitions Board Aircraft Committee.

LUBRICATION—BEARING *Problems* *in* AIRCRAFT GAS TURBINES

By E. M. PHILLIPS

STAFF ENGINEER, AIRCRAFT GAS TURBINE DEPARTMENT, GENERAL ELECTRIC COMPANY, WEST LYNN, MASS. MEMBER ASME

INTRODUCTION

THE success of the gas turbine, like that of any other high-speed rotating apparatus, is dependent upon most careful attention to the design and application of each of its parts. No part or detail can be considered unimportant or exempt from this rule. Certainly the gas-turbine main shaft bearings and their lubrication cannot be considered an exception. In apportioning design efforts among the various parts of the gas turbine, one might be tempted to conclude that bearings are stock items which could be assigned from a standard catalog and which, therefore, require no further attention. Such a decision would be unfortunate as it might well lead to a vast amount of extra development effort to save a design. The extensive damage resulting from failure of a bearing designed for supporting a high-speed rotor easily can force the abandonment or expensive redesign of a unit otherwise satisfactory.

The requirements for most bearings supporting a high-speed rotor might be listed as follows:

1 Ability to support the imposed load.
2 Minimum power loss.
3 Minimum wear.
4 Minimum scuffing and pitting damage.
5 Avoidance of excessive vibration.

These criteria assume the presence of sufficient lubricant to prevent metallic contact and to carry away the heat generated. However, bearings designed for aircraft gas turbines and the lubricant for them must satisfy much more than these basic requirements. They must operate satisfactorily at any temperature between —65 F and +250 or 275 F. Because of the weight penalty and the high cooling-air temperature with high-speed jet-propelled aircraft, it becomes difficult to maintain the top temperature limit in many designs, and it often becomes desirable that the limit be increased to at least 350 F. The gas turbine must start and accelerate quickly without excessive power requirement and with an ambient temperature at any point in the range from —65 F to +160 F. Because of the feedback of heat from the turbine buckets, the turbine bearing will reach a temperature in the neighborhood of 450 to 500 F after shutdown and after the flow of lubricant has stopped. This results in the evaporation of nearly all lubricant remaining in the bearing and oxidation of the remainder on the bearing surfaces. In starting up a bearing coated in this manner, it must not suffer damage while operating prior to the flow of lubricant being restored to the bearing. During airplane maneuvers the bearing must carry radial loads as high as fifteen times normal gravity, and maximum thrust loads at somewhat greater than fifteen times normal. The bearing also must accommodate a considerable angular movement of the rotor during these maneuvers.

HISTORY OF BEARING DEVELOPMENTS

From analysis of the potential advantages and disadvantages of the several bearing types, as well as from tests made during the development of the aircraft turbosupercharger, the author's company concluded that ball and roller antifriction bearings best satisfy its requirements. Later reanalyses to include the latest developments have led to the same conclusion as applied to the aircraft gas turbine, as well as the aircraft turbosupercharger. Experience has confirmed these conclusions. As new developments in any type of bearing are made available, or as the bearing requirements are modified, the advantages and disadvantages of each type will be reassessed. We shall look to bearing manufacturers and research organizations for future developments which will result in improvements in endurance, performance, load-carrying ability, limiting speed, and starting characteristics. Consideration will be given to any and all types of bearings meeting the requirements of existing and of future aircraft gas-turbine designs. Some of these future designs can be expected to present much more exacting requirements in greater peripheral speed, in larger size, and in higher operating temperature.

Unfortunately, there was little experience available to indicate the most satisfactory bearings applicable to the early aircraft turbosuperchargers or aircraft gas turbines. Much development and trial testing were needed. Journal types were first tried in aircraft turbosuperchargers. Little was then known as to limits for load and speed for antifriction bearings. Each new design application had been based upon previous test or application experience and upon the best estimate as to the possible safe extension beyond this experience. Each extension was checked carefully by laboratory and unit testing. Each application had to be analyzed for possible changes in requirements and the designs had to be modified to satisfy any such changes.

In a recent paper,[1] S. R. Puffer gives the early history of aircraft turbosupercharger bearings and their applications. The paper covers journal bearings with washer and pivoted-block types of thrust bearings and grease- and oil-lubricated ball and roller bearings. It traces the development of aircraft turbosupercharger bearings and their lubrication to the oil-lubricated ball and roller bearings applied to the turbosuperchargers of the Boeing B17 Flying Fortress, the Convair B36 airplane, and the Boeing Stratocruiser airplane. A typical illustration of these turbosupercharger applications is shown in Fig. 1.

More recent designs of journal-type bearings shown in Figs. 2 and 3 have been applied to aircraft turbosuperchargers. Fig. 2 shows the application of a silver-lead-indium journal bearing which is machined so as to provide a bellmouth effect for extra clearance at the ends to accommodate the angular movement

Contributed by the Aviation Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of The American Society of Mechanical Engineers.

[1] "Aircraft Turbosupercharger Bearings, Their History, Design, and Application Technique," by S. R. Puffer, Trans. ASME, vol. 73, 1951, pp. 1077 1084.

of the shaft during airplane maneuvers. In order to call attention to this feature, the bellmouth is shown exaggerated in Fig. 2.

Fig. 3 shows a floating-sleeve type of journal bearing. This bearing has two theoretical advantages; (1) lower relative peripheral speed because of the rotation of the sleeve at partial speed, and (2) additional freedom to accommodate the angular movement during maneuvering, because of the increased total oil-film thickness. Both of these designs proved satisfactory for development turbosupercharger applications. The disadvantages of higher power loss (than for antifriction bearings) and higher low-temperature starting-torque requirement, together with limited provision for angular movement of the shaft during maneuvering, make their application, as presently designed, to aircraft gas turbines very questionable.

The author's company has found that for aircraft gas-turbine applications ball and roller bearings best meet its requirements. In the early development of one unit, babbitted journal bearings with babbitt facing on one of the bearings for supporting thrust were used. This is shown in Fig. 4. However, because

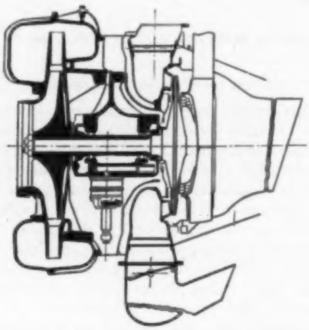


FIG. 1 TURBOSUPERCHARGER CROSS SECTION

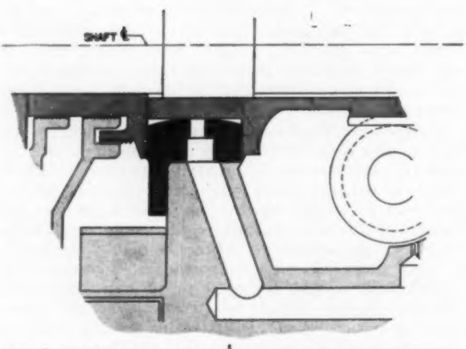


FIG. 2 TURBOSUPERCHARGER BEARING—SILVER-LEAD-INDIUM

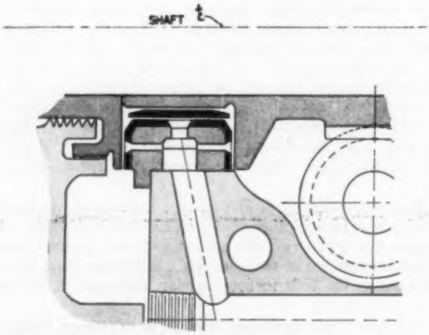


FIG. 3 TURBOSUPERCHARGER BEARING—FLOATING SLEEVE

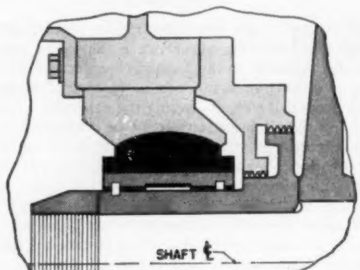


FIG. 4 AIRCRAFT GAS-TURBINE BEARING—JOURNAL TYPE

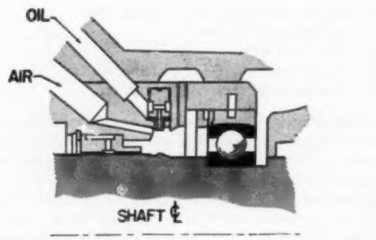


FIG. 5 AIRCRAFT GAS-TURBINE BEARING—MIST-LUBRICATED, METERED AT BEARING

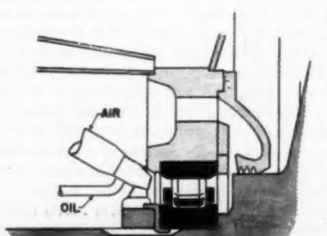


FIG. 6 AIRCRAFT GAS-TURBINE BEARING—MIST-LUBRICATED, METERED AT COMMON REGULATOR

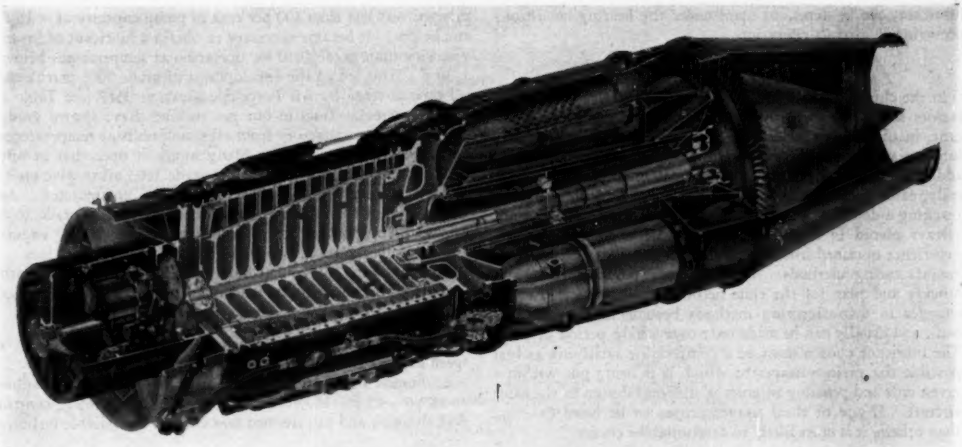


FIG. 9 AIRCRAFT GAS-TURBINE ASSEMBLY CROSS SECTION

FIG. 7 AIRCRAFT GAS-TURBINE BEARING—SOLID-OIL-JET-LUBRICATED

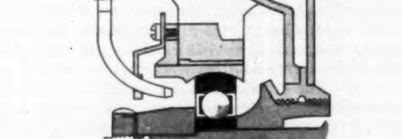


FIG. 8 AIRCRAFT GAS-TURBINE BEARING—SOLID-OIL-JET-LUBRICATED

of the high power losses and the high starting-torque requirements due to the main shaft and accessory gear-drive journal bearings, this design was modified to utilize ball and roller bearings throughout for the production model. The ball and roller bearings for some units have been lubricated by an oil mist wherein a metered oil supply is fed into and atomized by an air jet at the nozzles lubricating each of the bearings.

Fig. 5 shows such a system in which the metering nozzle is adjacent to the bearing, while Fig. 6 shows a design in which the oil for each of the bearings is metered by a common multipoint regulator. Because of the limitation in bearing cooling, the difficulty of separating the oil from the air or handling the large return volume of mist, and the resulting high oil-consumption rates, these systems have been replaced in the author's company by solid oil-jet lubrication in aircraft gas-turbine applications. However, both the systems illustrated in Figs. 5 and 6 performed satisfactorily, except as indicated by the foregoing limitations.

Figs. 7 and 8 show antifriction-type bearings with solid oil lubrication, while Fig. 9 shows an assembly of an aircraft gas turbine using such bearings. In these designs lubricating oil is fed through a nozzle adjacent to the ball or roller bearings and directed toward the clearance between retainer and bearing race. A small part of this oil enters the bearing and lubricates the rolling and sliding surfaces. The remainder is deflected by the retainer and races, carrying away heat and cooling these bearing parts. The amount of oil supplied to each bearing is controlled by orifices sufficient to maintain a safe operating temperature limit at the bearing. The oil also must keep the power loss in the bearing and the amount of heat which must be removed in the oil cooler to a minimum.

This system has proved highly successful, but as pointed out in Mr. Puffer's paper,[1] it is in direct violation of an early concept that high-speed antifriction bearings should be lubricated by a wick or dropper. The power loss in the bearing is naturally higher than when small amounts of oil sufficient only for lubrication are supplied by wick or dropper or when even larger amounts are atomized and supplied as an air-oil mist. However, this system furnishes a bearing capable of carrying heavy loads safely and one which, when supplied with the proper

lubricant, can be depended upon under the bearing conditions occurring in aircraft operation.

CHOICE OF LUBRICANT

In the choice of a lubricant for an aircraft gas turbine, many factors must be considered. In the usual design, the lubricant, in addition to lubricating and cooling the bearings, also lubricates and cools the gear mesh and acts as a hydraulic fluid and lubricant for governing and control mechanisms. Naturally, each of these usages must be taken into consideration in reaching a decision. In making his choice the engineer is not always placed in an ideal position. He must consider the experience obtained from former designs as built under existing manufacturing methods. While he may modify his designs quickly and plan for the time needed to verify them, radical changes in manufacturing methods become much more difficult and usually can be made only over a long period of time. The lubricant chosen must be a compromise satisfying as best possible the various usages to which it is being put within a given unit and possibly in units of different design in the same aircraft. If one of these usages proves to be more exacting than others, it is most likely to determine the choice.

VISCOSITY OF LUBRICANTS

Since the power loss in a bearing and also the starting torque required become greater as the viscosity is increased, it is desirable to use a lubricant having as low viscosity as possible consistent with load-carrying ability and freedom from evaporation or boiling off of the lighter constituents at the higher operating temperatures encountered. This led to the use of a petroleum oil having a viscosity of 10 centistokes at 100 F (Army-Navy Aeronautical Specification MIL-O-6081, Grade 1010)(see Table 1 for properties) for many of the jet-propulsion

TABLE 1 PROPERTIES OF LUBRICANTS

Specification	MIL-O-6081 Grade 1010	AF3519 Grade 1005	MIL-O-6086 Grade M
Viscosity, centistokes			
at 210 F	2.53	1.63	
at 100 F	10 min[a]	5.0 min[a]	60–82[a]
at 0 F	220	52	
at −20 F	685	115	
at −40 F	3000 max[a]	400 max[a]	
at −65 F	....	2600	
at −67 F	40000	..	
Viscosity index	70	83	
Pour point, deg F	−70 max[a]	−75 max[a]	−20 max[a]
Low-temperature stability, deg F	−65 max[a]	−65 [a]	
Flash point, deg F	265 min[a]	225 min[a]	310 min[a]
Fire point, deg F	...	....	....
Pressure-wear index (min)	....	....	15
Remarks	+ Antioxidant	+ Antioxidant	Sulphurized load-carrying improver added

[a] Specification requirements.

gas turbines. However, because of the heavy loads on gearing and the wear characteristics of the gears, especially during early running, most builders of propeller-propulsion gas turbines have found it necessary to use a heavier oil in these units. Such an oil with wear-improver additive (MIL-O-6086, Grade M) (see Table 1 for properties) has been applied.

In tests by the author's company, the grade 1010 oil was found to be satisfactory for operation in all our modern turbojet engines at temperatures above —30 F from the standpoints of control operation, lubrication of bearings and gears, and amount of lubricant pumped. Actually, the quantity of oil pumped was less than 100 per cent of pump capacity at —18 F and below. It became necessary to obtain a lubricant of lower viscosity than grade 1010 for operation at temperatures below —30 F. This led to the development of grade 1005 petroleum oil now covered by Air Force Specification 3519 (see Table 1 for properties). Tests in our gas turbines have shown grade 1005 oil to be satisfactory from all standpoints at temperatures at least as low as —65 F. Many hours of operation in test cells and in flight have shown the grade 1005 oil to give satisfactory performance at all temperatures encountered. As given by Saul Barron[2] in a recent paper, the use of grade 1005 oil has been approved for all temperatures for the J47 engine and for temperatures below +20 F for the J33 and J35 engines.

The following additional data obtained from testing with grade 1010 oil point up the inadequacy of this grade for service at temperatures below —30 F:

1 At —65 F, adequate lubrication was not provided at a speed of more than 28 per cent of top operating speed.

2 Engine control was good down to —30 F and possibly down to —65 F. However, in the region near —65 F, control was sluggish and not deemed fast enough for reliable military service.

3 At idle speed, oil flows of 100 per cent of pump capacity were obtainable down to —50 F (grade 1005 oil gave full pump capacity down to temperatures below —65 F).

4 At idle speed oil flow was below 25 per cent of pump capacity at —69 F.

5 Runs at —36 and —38 F oil-inlet temperature at top speed showed very low flow with no increase in flow for 7 and $7^1/_2$ min after return to lower speeds.

6 Runs at top speed with oil-inlet temperature below —40 F showed extreme restriction in flow with zero flow at —60 F, which remained zero despite return to idle speed.

As indicated in the foregoing, the experience of some aircraft gas-turbine builders has pointed to a need of a higher-viscosity lubricant for operation above +20 F and of a still higher viscosity with load-carrying additive where heavily loaded gears are involved. The experience of the author's company indicates that with accurately cut smooth gears, scuffing at high loads occurs at very low speeds only, and that heavy loads can be carried with little wear and without pitting or scuffing on accurately cut smooth surfaces lubricated with light oil. Hertz stresses as high as 120,000 psi have been carried on medium-hardness gears at high speed without scuffing or pitting, whereas a rougher surface will fail at about one half of this value. Rolls of hard material and fine finish have carried loads giving a Hertz stress of 350,000 psi without grief. The smoothness of the surface appears to be the most significant factor.

TURBINE-BEARING REQUIREMENT

After the gas turbine is shut down, heat stored in the turbine wheel disk flows into the turbine bearing and, since the cooling-lubricant flow has stopped, the bearing heats up and evaporates most of the oil remaining on metal surfaces, leaving only a "varnishlike" deposit. The standard roller bearing used in this location once had a roller retainer of free-machining yellow brass with sliding contact on the narrow end shoulders on the inner race. Upon starting-up, during the period before an adequate lubricating film had been established at the bearing surfaces of the retainer with the inner race and with the rollers, the dry bearing experienced seizure and considerable smearing of brass on the steel parts at these sliding surfaces. This soon

[2] "Low Temperature Lubrication of Aircraft Engines," by Saul Barron, Power Plant Laboratory, Air Materiel Command, presented at the SAE Annual Meeting, Detroit, Mich., January 8–12, 1951.

TABLE 3 BEHAVIOR OF VARIOUS SEPARATOR MATERIALS UNDER DIFFERENT TEST PROCEDURES

Separator material	Procedure A, steady lubr. run	Procedure B multiple starts	Procedure C, 5 delayed lubr. starts	Procedure D, baked oil operation to failure	Procedure E2, dry operation to failure
Leaded yellow brass	No metal transfer	Very slight transfer	Noticeable transfer	3.77 min avg	3.03 min avg
Chromium plate	...	No transfer; wears inner race	No transfer; serious wear on inner race	....	....
Silver plate	No metal transfer	No metal transfer	Trace of silver on inner race	292 min avg; plate worn off in small areas	6.17 min avg
Silver-lead-indium plate	No metal transfer	No metal transfer; some wear in pockets	Slight metal transfer	115 min; plate worn off in spots	....
85-12-3 lead-tin-copper plate	No metal transfer	Very slight transfer; contact areas polished	No metal transfer	81 min; much plating worn off in pockets and on lands	....
97-3 tin-copper plate	No metal transfer	Slight metal transfer; contact areas large but polished	Slight metal transfer	9.4 min; heavy metal transfer to rolls and races	....

Notes:

Procedure A *Steady Lubricated Run.* Operation is continued for 24 hr with grade 1010 oil furnished each bearing at rate of 0.50 gpm. Bearing temperatures are maintained at 248 F.

Procedure B *Multiple Starts.* Oil is fed continuously to each bearing at rate of 0.5 gpm, and bearing temperatures maintained at 248 F. Seventy-five starts are made with an operating period of 2 min and an off period of 5 min.

Procedure C *Delayed Lubrication Starts.* After operating bearings for 5 min with normal lubrication, they are stopped and heated to 369 F. After 2 hr in this temperature, the roller bearings are started dry, and 10 sec later oil is admitted. After 5 min running, this procedure is repeated until five starts have been made.

Procedure D *Baked Oil Operation to Failure.* Roller bearings are installed clean and dry and are heated to 266 F. Oil is turned on and they are operated at this temperature with oil fed for 5 min. They are stopped and heated to 425 F and maintain this temperature for 2 hr. After cooling to 369 F, roller bearings are operated without lubrication to failure.

Procedure E2 *Dry Operation to Failure.* New bearings are operated with oil lubrication for 5 min. They are then removed and cleaned in a volatile hydrocarbon solvent, then dried and replaced. They are operated without lubrication to failure.

TABLE 2 COMPARISON OF RUNNING TIME TO FAILURE OF 95-MM ROLLER BEARINGS WITH BRASS AND SILVER-PLATED SEPARATORS BY PROCEDURE D[a] (BAKED OIL OPERATION TO FAILURE)

Time to failure, min	
Brass separator	Silver-plated separator
4.17	409
6.81	72
0.32	395
3.77 avg	292 avg

[a] See end of Table 3 for description.

led to failure of the bearing. To determine the mechanism of these failures and the means of preventing failure, a test program on 95-mm roller bearings was set up in the Thomson Laboratory of the author's company. Results of this test program have been published in a paper by Dr. D. F. Wilcock and F. C. Jones.[3] Tables 2 and 3, taken from this paper, show the effect of plating on the running time to failure and on metal transfer.

Under procedure D, consisting of operating to failure of roller bearings, which after a previous 5-min run with grade 1010 oil had been dried out for 2 hr at 425 F, silver-plated retainers lasted on an average of 77 times as long as the unplated retainer (292 min against 3.77 min). This was better than any of the other platings. Table 3 also shows that the bearing with silver-plated retainer gave improved test performance on the other test schedules. No difficulty was experienced with any of the separators or retainers tested with continuous lubrication. Roller bearings with silver-plated retainers applied adjacent to the hot turbine wheel disks of aircraft gas turbines give excellent performance in service.

Since the cited paper[3] was prepared, tests made by the Thomson Laboratory of the author's company have shown retainers of Monel metal to have 3 to 4 times the life of silver-plated yellow-brass retainers. A modified "H" Monel was used. This would indicate that retainers of Monel metal may permit applications at still higher temperatures.

BALL-BEARING FAILURE

It is important that ball or roller bearings have sufficient clearance so as to prevent binding and the resultant loading from unequal temperatures of inner and outer races, whether caused by heating from friction in the bearing or from conduction from hot parts. Evidences of such insufficient clearance have been discovered in early testing of some units. In an effort to determine the causes of failure in high-speed ball bearings and to verify deductions from indications on test, a laboratory program was undertaken on 50-mm medium series ball bearings, number 310, operating at 13,200 rpm. With a radial load of 30 lb and a thrust load of 200 to 300 lb, failure could be produced by lack of oil or by elimination of internal clearance

[3] "Improved High-Speed Roller Bearings," by D. F. Wilcock and F. C. Jones, *Lubrication Engineering*, vol. 5, June, 1949, pp. 129–133.

due to heating of the inner race if combined with passage of dirt through the bearing. No failure was produced by any of the following when acting alone:

1 High thrust.
2 Reverse thrust.
3 Unbalanced radial load with vibration at a frequency equal to the rotational speed.
4 Elimination of internal clearance.
5 Lots of dirt (carborundum, steel chips, cast-iron chips, or aluminum chips)—races were marked but no failure resulted.

During this test program, bearings were stopped before complete failure, and tracking observed on the races and balls showed three pitted areas separated by two shiny bands made by pure rolling. This phenomenon was explained in a paper[4] presented to this Society 2 years ago. Further laboratory tests, which have been made since the paper was published, have shown that pitting due to slipping was experienced by these ball bearings when operated dry under delayed lubrication starts of 10 sec, in accordance with Schedule C shown in Table 3.[3] Therefore, failure of these ball bearings could be expected if they were operated after being subjected to the same delayed lubrication starts successfully handled by the roller bearings with silver-plated retainers previously referred to. This would indicate that ball bearings should not be applied in locations where the lubricant can be evaporated at shutdown, unless lubrication can be provided prior to again starting up.

LARGER-SIZE ROLLER BEARINGS

In extending the application of ball or roller bearings in addition to limiting loads and *DN*-values (diameter multiplied by speed), consideration must be given to the method of lubrication and the design proportions of the bearing. The standard method of lubrication had been to supply oil by a single jet and to drain from both sides of the bearing. In a study to determine operating characteristics of a 140-mm light series roller bearing at 7500 rpm, a test program was initiated on the bearing test stand at the bearing center of the Thomson Laboratory. In attempting to operate with this standard method of lubrication, some bearings could not be brought up to full speed because of chatter, while others operated very noisily at full speed. Examination showed the brass separators to be heavily marked on diagonally opposite portions of the lands riding on the inner race, indicating a tendency of the separators to cock and cause heavy bearing on the narrow lands. Substitution of silver-plated separators showed very little gain. Several methods were found to obtain successful running, as follows:

1 Reduction in the running clearance between the separator and the inner race, thus limiting the amount of tipping permitted.
2 Increasing the width of the separator and inner race.
3 Changing material of separator to Monel metal.
4 Changing the lubrication method to provide an oil jet on each side of the bearing and to restrict the drain on one side.

CONCLUSIONS

Experience gained from the use of high-speed ball and roller bearings in aircraft turbosuperchargers and aircraft gas turbines provides much of the information needed for the successful application of these types of bearings to new designs. Some further basic data are available from laboratory tests. However, both of these sources fail to provide all the information required. Much more basic data applicable to new and more exacting designs should be made available to engineers. This should include studies involving designs of bearings, materials, and lubrication for temperatures in excess of those in present applications. These additional basic data can best be obtained from laboratory tests of bearings rather than from the more difficult, slower, and more expensive tests in aircraft gas turbines.

ACKNOWLEDGMENT

The author wishes to thank Dr. D. F. Wilcock, head of the Bearing Center, Thomson Laboratory, General Electric Company, for the test information published herein.

[4] "The Mechanism of Lubrication Failure in High-Speed Ball Bearings," by F. C. Jones and D. F. Wilcock, Trans. ASME, vol. 72, 1950, pp. 817-823.

Relating Industrial Research to the Company

(*Continued from page 970*)

guage of other people in the company and making it look logical and attractive to them.

GOOD BUSINESS THINKING

In closing, we want to consider the problem of good business thinking by research and engineering people. It becomes evident from the things we have considered here and of the observations we make every day that it becomes more and more necessary for technical people to assume responsibility for the business aspects of their work. We have all heard technical people complain in the past that they were not getting a fair share of the rewards of society for the contributions that they are making. No doubt a good bit of this has been their own fault, and it is gratifying that technical people today are taking courses in economics and in business management, along with their technical training.

Along this line, we as technical people must take an interest in our projects from the standpoint of markets and costs. These things must be considered in our choice of projects and our techniques for solving them. The analysis of markets is no longer simply a matter of getting an opinion on the salability of an article as a "yes" and "no" answer. It is a problem of evaluating what technical solution would have a marketable value. This type of market analysis has come to be known as "technical-economic analysis." It is entirely possible to do a very perfect development job on a device that no one wants.

Also, it is well if we as research and engineering people know something of the financial management problems of the company. For example, any efficient research department will probably come out with more ideas than the company has ventured capital to develop, and some will need to wait on the shelf. Research should not be discouraged at this and should be helpful with information on which projects offer the most promise and would take the least time regarding the investment in production facilities and sales expense to bring them to the point where they can be profitable.

In closing, I would like to say that I have written a fairly large order for research. We may not be able to come up to these ideals but it is a great deal of fun trying to apply these few simple and proved principles, and there is real satisfaction in the results.

WANTED—ENGINEERS

By WILLIS F. THOMPSON

CHAIRMAN, GUIDANCE COMMITTEE, ECPD. VICE-PRESIDENT, REGION I, ASME

ENGINEERING OPPORTUNITIES AND REWARDS

SINCE the beginning of the Korean war, nearly every newspaper has been carrying help-wanted advertisements for engineers in their columns. The shortage of engineers becomes greater with each passing month and has now reached a stage much more critical to the defense effort of the Nation than is the shortage of carbon steel, structural steel, alloy steel, stainless steel, copper, copper-base alloys, and aluminum. With the increased spending for armaments which will now occur due to recent acts of Congress, we can anticipate an engineering manpower shortage, the severity of which will have no previous equal in any nation, which may easily result in a perceptible change to our existing social order.

There are now well over 400,000 engineers employed in all branches of the profession and, using conservative figures, we are now short well more than 95,000 engineers. The demand for engineering graduates every year in the foreseeable future is placed at not less than 40,000, and reliable data indicate the demand is close to 45,000. This is after 52,000 engineers were graduated in 1950, the largest class ever to graduate, and 38,000 in 1951. These engineering graduates were immediately absorbed, and the smaller class of 1952, which numbers about 25,000, will all be promised long before graduation day. The 1953 class, on the basis of present enrollments, will be a scant 19,000, and the 1954 class is expected to be even lower. Local draft boards may already have drafted a sufficient number of young men for the military service who are technically inclined to reduce the number of graduates to an insignificant low in 1955.

The present demand for engineers is not due entirely to our defense effort. At least 30,000 engineers each year are needed in this country for normal replacements and growth. The military services take in the order of another 15,000 engineers annually. Industrial research and development have increased more than 500 per cent since the beginning of World War II while the number of scientists and engineers has barely doubled. To this demand there must, of course, be added the large number of scientists and engineers who are now in government research.

From the best information obtainable at present, Russia is now producing 30,000 graduate engineers per annum from universities and 70,000 graduates from technical institutions. It should therefore be apparent to everyone in the engineering profession that, in so far as guidance work is concerned, we are very much behind schedule and every effort possible must be expended to keep the "pipe line" filled through which technical personnel are educated and developed.

I am not at all satisfied that industry is now using engineers efficiently. An engineer's training makes him easily adaptable to nonengineering positions in industry and many are now so engaged. Proper utilization of engineers in industry is now absolutely necessary if we are to make our maximum contribution to the nation.

It is unfortunate that it was necessary for so many engineers, both experienced and otherwise, during the 1930's to accept nonengineering positions to earn a livelihood. Many of these men are lost forever to the profession and this displacement, I believe, is one of the principal causes of our present shortage of engineers.

It is inevitable, therefore, that the shortage of engineers will create unparalleled opportunities for both men and women entering engineering study during at least the next ten years. I have been informed that one large electrical manufacturing concern announced lately it was planning to recruit 500 women college graduates in engineering, sciences, and mathematics to help the engineering-trained men in its organization. As the shortage of qualified men becomes more acute, the opportunities of qualified women in engineering becomes greater than ever before. Many young women with an aptitude for mathematics, the physical sciences, and English have become very successful in engineering.

Considering the United States as a whole, the average engineer is in the same earnings class as the physician and the lawyer. Like them, his earnings vary widely with his ability and with business conditions as a whole, being significantly higher during booms and much lower during depressions. The median earnings for beginners, that is, those who have just been granted their college degrees, is now about $3750 per year. The median earnings of engineers with 25 years of practice is now near $8000 per year. The earnings of those who remain in the strictly technical brackets is less than those who take on administrative duties. There is, as in every other profession, a minority who lack the drive, or the teamwork personality, to achieve high earnings, and at the other end of the scale, there is a minority embracing those who reach $15,000 or more about 20 or 25 years after graduation.

As in all careers, and especially in the professions, the rewards of engineering may be regarded as coming from several sources, such as,

(*a*) Personal satisfaction with the actual activity of the occupation.

(*b*) Social satisfaction because of the usefulness of the services rendered.

(*c*) Financial satisfaction arising from the earnings received.

ECPD AND ITS OBJECTIVES THROUGH STUDENT GUIDANCE

It would not be remiss at this time to review what the Engineers' Council for Professional Development is all about. Back in October, 1932, ECPD was organized for the purpose of promoting the welfare of individual engineers. During the early 30's a great need existed for a joint program by all of the engineering societies for the purpose of creating more respect for engineering as a profession and at the same time establishing a recognized procedure for certification. ECPD has now been in action for nearly twenty years and, although its work will never be finished, its accomplishments to date have benefited the engineering profession greatly.

Probably the most conspicuous of ECPD's accomplishments is its program of accrediting engineering curricula which has been conducted by its Education Committee. As of October, 1949, some 991 curricula had been inspected and evaluated, and 734 accredited at 146 degree-granting institutions in the United States. Twenty-five curricula had been accredited at 13 tech-

Presented at the 19th Annual Meeting, Boston, Mass., Oct. 19–21, 1951, of Engineers' Council for Professional Development.

nical institutes in an initial extension of the accrediting program to this type of training.

Like any other organization, ECPD must depend upon the efforts of individual members of its engineering societies' affiliates who are interested in and have become familiar with its objectives. These objectives are: To co-ordinate and promote efforts to attain higher professional standards of education and practice; greater solidarity of the engineering profession; and greater effectiveness in dealing with technical, economic, and social problems.

ECPD is not an independent body but derives financial support and its administrative personnel from its constituent organizations.

One of the basic ECPD concepts is that there are four normal stages in the life of the engineer and the profession as a whole must recognize that it has a responsibility in each stage as the engineer advances through life. The four stages are:

1 The precollege stage.

2 The undergraduate stage.

3 The engineer-in-training stage.

4 The stage of full professional practice.

The Guidance Committee of ECPD is interested in the first, or precollege stage, and we concern ourselves mostly with students at the secondary-school level who are qualified to enter the engineering profession. It is our purpose to provide these students with a means for educational and vocational orientation with respect to the opportunities and responsibilities of the profession. Our most important work is to insure that only those having the personal qualities, aptitudes, and capacities required of engineers will seek entrance to the profession through engineering schools. The Committee's objectives, as set forth in ECPD's Charter and Rules of Procedure, are as follows:

"The Guidance Committee shall develop, and review regularly, methods for guiding young men who seek entrance to the engineering schools so that those who enter will have the high quality, aptitude, and capacity required of engineers in the particular branches of engineering that they select. The Committee shall develop, and modify when necessary, an active program of co-operation with engineering and other groups so that the guidance methods developed will be put to useful purpose. The Committee shall report annually what response has been received to its program."

The attainment of the Committee's principal objectives involves:

1 "The supplying of information to each student or potential student concerning the qualifications essential for success in the profession of engineering.

2 "Continuing assistance to the various local engineering groups and their agencies which guide high-school students in the selection of first-year college curriculum.

3 "Stipulation of a more active participation of the local organization of ECPD constituent societies in the active promotion of ECPD objectives at the community level."

HOW THE ECPD GUIDANCE COMMITTEE FUNCTIONS

The national ECPD Guidance Committee, at present, is composed of eleven members. The United States has been subdivided into eight regions, each of which has a regional chairman who is a member of the Guidance Committee. The regions are as follows:

Region I: New England.
Region II: New York and New Jersey.
Region III: Pennsylvania, Maryland, Delaware, District of Columbia.
Region IV: Virginia, North Carolina, South Carolina, Tennessee, Mississippi, Alabama, Georgia, Florida.
Region V: Michigan, Indiana, Ohio, Kentucky, West Virginia.
Region VI: North Dakota, South Dakota, Nebraska, Wisconsin, Minnesota, Iowa, Michigan, Illinois.
Region VII: Oregon, Washington, California, Nevada, Idaho, Utah, Arizona.
Region VIII: Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Arkansas, Louisiana.

Canada will also be subdivided into four regions, each region being similar to a division of the Engineering Institute Committee zone system. It is expected that Alaska and Hawaii will each be one region.

Every state in each region in the United States will have a state chairman who will be selected by the regional guidance chairman. The state chairmen, in turn, will select their county, city, and town chairmen. The National Guidance Committee has no intention of interfering with local procedure or autonomy and the national network will disseminate information as to guidance methods used in various localities which seem to have advantage and which other localities may wish to adopt after trial.

We believe that the work of guidance can best be accomplished by having regional and state guidance committees come under the leadership of ECPD. The ECPD Guidance Committee is recommending to its regional chairmen:

1 State and local forums for discussion of improved methods of procedure.

2 The exchange of ideas as to how best to obtain the co-operation of boards of education and high-school principals.

3 Organization of a speakers' bureau which will cover completely the field of engineering—at least, civil, electrical, mechanical, mining, and chemical engineering.

4 The accumulation of lists of publications now available to aid those engineers who volunteer to engage in this valuable contribution to industry, to the profession, and to the coming generation of American citizens.

Recently the Engineering Manpower Commission of the Engineers Joint Council has contacted by mail some 23,000 high-school principals, sending each a copy of our booklet "Engineering as a Career," and we are requesting our regional and state organizations to follow up these contacts as soon as possible.

Engineers Joint Council recently scheduled in Pittsburgh a full-scale meeting of engineers from various societies throughout the United States. At that meeting facts about shortages of engineers were discussed in detail and the delegates were urged to set up or assist in local programs to counteract the shortage. Recent action by Charles E. Wilson, Defense Mobilizer, in setting up a commission for specialized manpower, headed by Dr. Arthur Fleming, may help in solving some of the problems concerning the manpower shortage. Engineers Joint Council has suggested to Dr. Fleming that steps should be taken in halting the employment of engineers in positions that do not have to be filled by technical men in both industry and the armed forces. The Council further implored the new commission not to shut off the flow of students to engineering colleges in the attempt to maintain an army of 3,500,000 men.

The flow of high-school graduates to engineering colleges and technical schools would, with our present guidance organization, be maintained except for interference by the Selective Service system.

The Engineering Manpower Commission and other interested groups are urging deferment of an adequate number of college students in engineering and science at undergraduate and advanced levels. A bill was introduced in Congress to make this deferment mandatory but it failed to be enacted into law. All deferments are therefore acted upon at the local level.

STUDENTS AND COUNSELORS

It should be remembered by all persons interested in student-guidance work that high-school graduating classes are now composed of boys and girls who were born in the depression of the early or middle 1930's. Many of their parents have lived on relief and the children have been exposed to a philosophy of life quite foreign to the system of government under which we received our elementary education.

High-school counselors are usually to be found part of the faculty and in many instances have between 200 and 300 students to counsel not only in engineering but also in other professions and vocations. In a good many instances, these counselors have the dual job of acting both as parent and counselor.

It should be mentioned at this time that, while we live under a war and peace economy, high-school teachers who are good counselors and reside in industrial areas are exposed to the lure of higher salaries offered by industrial concerns who are continuously in the market for trained men in the field of personnel work. Many good high-school teachers and counselors were lost to industry during World War II and the same thing is happening now. Counselors who are part of the high-school faculty must not only maintain their home-room discipline but, in some instances, teach as many as one-half dozen or more classes per day. Therefore it should be apparent to everyone that any assistance which they can receive in guidance work will be greatly appreciated.

Those of us who are interested in guidance and have been in direct contact with boys and girls of the present high-school age, cannot help but have been impressed not only with their high level of intelligence but also with their sincere and earnest desire to become good citizens. It is the speaker's opinion that at no time in our country's history have we, on the average, produced better high-school students in spite of the time and circumstances under which we now live.

WHAT APTITUDES ARE REQUIRED?

The best prospect for successfully completing the engineering-college course is the industrious high-school student who shows:

1 Ability to get along well with his fellow students.

2 Scholastic proficiency, particularly in mathematics, the physical sciences, and English.

Students who score in the top third of their class on standardized tests in mathematics and physical sciences should be encouraged to follow the strongest sequence of English, mathematics, and the science courses available to them. In this way they can best prepare themselves for entrance to the engineering college of their choice.

Aptitude tests which are considered to be especially useful for seventh through twelfth-grade students are available through the Cooperative Division, Educational Testing Service, 20 Nassau St., Princeton, N. J. These tests, now being used in several areas, are achievement tests in mathematics, physical science, and English and have been found repeatedly to yield good predictions of scholastic success in engineering.

In many engineering colleges a mathematics test of the appropriate level has provided better prediction for entering freshmen than a scholastic aptitude test. A scholastic aptitude test often predicts about as accurately as do secondary-school grades. Good scholastic aptitude tests, such as the American Council on Education Psychological Examination for High School Student's or the Scholastic Aptitude Test of the College Entrance Examination Board, could be used.

RECOMMENDATIONS

I want to close this talk by leaving with you ten suggestions which, if followed, I am sure will help to reduce the shortage of engineers in the future. They are:

1 Give every assistance to your ECPD state chairman in organizing guidance committees.

2 All ECPD state chairmen should notify the Selective Service authorities in their states that guidance committees are available to every draft board for consultation regarding deferment of technically inclined high-school students.

3 The ECPD Guidance Committee in every area should notify the local high-school principals and counselors that their committee is available and ready to assist in counseling students who wish information in connection with an engineering education.

4 The ECPD Guidance Committee in every area should learn who the honorary chairmen and the chairmen of the high-school science clubs are and inform them that speakers are available to talk to the clubs about the possibilities existing in the engineering profession.

5 State and local ECPD guidance committees should hold forums for discussion in improved methods of procedure.

6 The state and local ECPD guidance committees should suggest to local professional-engineering chapters, sections, councils, and other engineering groups that at least one of their meetings this winter should concern itself with the shortage of engineers.

7 Every member of the engineering profession should inform his clients, associates, friends, and neighbors of the existing critical shortage of engineers with the purpose of directing more young people into the profession, and guidance committee should also attempt to convince a great many engineers now retired that at least for the next few years they should again assume an active part in the work of the profession.

8 Where industry is not using engineers to the full extent of their ability, the local ECPD committees should find ways and means of bringing the matter to the attention of the proper officials directly concerned.

9 Where our armed forces are known not to make the most suitable use of engineers who have been called or drafted into the service, the regional chairman of ECPD should obtain and forward complete information to the National Guidance Committee.

10 All engineers and others interested in guidance work should send to their local ECPD guidance committee suggestions that may improve engineering guidance and the names and addresses of those qualified to serve on regional committees or otherwise contribute to the progress of guidance work.

THE ECPD Guidance Committee referred to in this article consists of Willis F. Thompson, *chairman;* Ernest Hartford, executive assistant secretary ASME, *secretary;* and L. M. K. Boelter, Los Angeles, Calif.; M. D. Cooper, Pittsburgh, Pa., M. S. Coover, Ames, Iowa; A. J. Ferritti, Boston, Mass.; Roy M. Green, Lincoln, Neb.; H. P. Hammond, State College, Pa.; A. R. Hellwarth, Detroit, Mich.; G. K. Hickin, New York, N. Y.; J. H. Lampe, Raleigh, N. C.; G. B. Moxon, Montreal, Canada; and C. L. Svenson, Austin, Texas.—EDITOR.

The ENGINEER *and* *the* AMERICAN WAY *of* LIFE

By J. CALVIN BROWN, PRESIDENT ASME

OUR forefathers very wisely recognized the need for technological advancement at the very beginning of our nation. The need for technological devices was recognized and incorporated into our Constitution, Article I, Section 8, subdivision 8, which reads:

"To promote the progress of science, and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

EARLY DAYS OF AMERICAN TECHNOLOGY

Why was Article I, Section 8, subdivision 8, placed in the Constitution? Prior to the Revolution, and for several generations before the separation of the thirteen Colonies from the mother country, Great Britain, the inhabitants of the Colonies had suffered from restraints that ruined their manufactures and commerce. In 1718, Maryland and Virginia produced iron for exportation to England. We know from a parliamentary report, that in 1731, and in New England, there were only 6 furnaces, 19 forges, a slitting mill, and a nail factory. The next year the English Parliament prohibited the exportation from one Colony to another or to England of hats made in the Colonies. This shortsighted condition on the part of Parliament continued and in 1750, Parliament forbade the erection or operation in the Colonies of a mill or other engine for slitting or rolling of iron or any furnace for making steel, and imposed a penalty of £200 sterling for each contravention of the law.

Again, Parliament, in 1752, banned the exportation to the Colonies of tools for use in the making of fabrics from linen or cotton, and in 1875, two years after the treaty of peace between England and the Colonies and two years before our Federal Constitution was framed, Parliament prohibited, by law, the emigration of mechanics and workmen familiar with the manufacture of iron and forbade the exportation not only of engines, machines, or tools useful in the processing of iron, but even the models and plans of such mechanisms and implements. In other words, the British Parliament attempted in every possible way to suppress any Colonial efforts to establish industry. The Colonial period was a machineless age, and President Washington made a recommendation to the Congress that the Congress give effectual encouragement to the exertion of skill and genius at home.

How well the framers of our Constitution and the Congress of that day encouraged technological advancement is indicated by the present position occupied by the United States industrially and technologically in the family of nations. I assert, without fear of contradiction, that the encouragement given to scientists and engineers in the United States has stimulated scientists and engineers to originate the major portion of the important industrial and basic inventions for the past 175 years, and facilitated rapid development of new discoveries in the United States to an extent greater than that of any other nation.

Presented at the Dinner during the Fall Meeting, Minneapolis, Minn., September 25–28, 1951, of The American Society of Mechanical Engineers.

OUR ECONOMIC POSITION IN THE WORLD

Today the United States has a population, as of April 1, 1950, of 153,697,361—according to Roy V. Peel, Director, Bureau of the Census—and represents 7 per cent of the world's population and 6 per cent of the world's area. Yet, during the brief period of this nation's existence, 7 per cent of the world's population has 46 per cent of the world's electric power, 59 per cent of its steel capacity, and 33 per cent of its railroads. The United States drives 80 per cent of the world's automobiles, uses 60 per cent of all telephone and telegraph facilities, owns 50 per cent of the world's radios, and 92 per cent of its modern bathtubs. Europe, roughly, has a population of 500,000,000 while Asia has a population of more than one billion, and yet the 150,000,000 people of the United States have more purchasing power than the entire populations of Europe and Asia.

When we consider our consumption of products, we find that the United States alone consumes 50 per cent of the world's rubber, 35 per cent of all tanned leather, 65 per cent of all silk, 35 per cent of all wool, 24 per cent of all cotton, and over 50 per cent of the world's coffee. It is very evident that this nation is progressive, industrious, and has a higher standard of living than any other nation. Our progression can be attributed directly to technological advancement and the free-enterprise system which is a part of the American way of life. This nation is founded on the principle of equal opportunity for all, and individuals with lowly birth have risen to high places.

Illiteracy in the United States has steadily declined and of the then 106,000,000 persons in October of 1947, who were 14 years of age and over, about 2,800,000 or 2.7 per cent were unable to read or write, either in English or in any other language. In 1870, in the United States, approximately 20 per cent were illiterate and in 1880, 17 per cent; by 1920, 6 per cent, and in 1930, 4.3 per cent, which shows a steady decrease in illiteracy. For instance, in 1930, illiteracy among native whites in the United States averaged 1.5 per cent, and among negroes 16.3 per cent. Among the foreign-born whites, the average was 9.9 per cent, ranging from 0.3 per cent among Scots, 0.6 per cent among English and Canadians, and 36.9 per cent for persons from the rest of the world. Statistics show that in the Middle East, from India to Egypt, and from Russia to the Indian Ocean, the percentage of illiteracy is over 95 per cent.

The significance of illiteracy is not merely that the people are unable to read or write in any language, but it is that society has no place for education. In the United States, and under our American way of life, we cure illiteracy by building schools and compelling children to attend classes. The graduates from these schools take their place in our society. What happens in a backward country? Every child put in a school comes out unfitted to play his normal role in his own society. There are factors in the Near East and Asia among the backward countries that oppose education. One of them is tradition. A second is religion. A further factor opposing education in Asia and the Near East is the concentration of wealth in the hands of 1 or 2 per cent of the population.

Perhaps some readers are familiar with an article entitled, "U.S.A., The Permanent Revolution," published in the Febru-

ary, 1951, issue of *Fortune*. Thereafter, this article was reproduced in book form under the same title, and is now available in bookstores. I have read this book with keen interest. This book points out some figures recently made public by the Federal Reserve Board that four out of ten American families possess at least $5,000 of assets over liabilities, and that nearly one family in ten has net assets of $25,000 or more. Thus, in the American way of life, we do not operate on just a capitalistic system, but we have a capitalistic people. According to the authors of this book, the American way of life is based upon two important elements—one, the particulars which Americans do not expect other peoples to share with them, inasmuch as they are peculiar to Americans, and the other, certain universals which Americans believe belong to all mankind and the nature of which it is the American task to unfold. Thus, under the first classification, and according to the authors, the American admits that his society is materialistic; that standardization is an essential of the way of life; and that conformity is a danger he must watch and learn to counteract. The American way of life is of the creative type and can be achieved through decentralization, that is to say, through a diversity of operations.

SOCIOLOGICAL EFFECTS OF TECHNOLOGY

From a certain point of view, most of the great problems of our time have arisen from the more or less violent impact of technology on the institutions and beliefs of mankind. Throughout the civilized world the technical revolution has shaken not only our governments but the most elementary concepts of government. It has created the social problem as we know it in the modern terms. And while in one sense setting men free, or giving them new hope of freedom, it has in another sense threatened them with new forms of enslavement. One of the great achievements of the American system has been its ability to absorb, and even to encourage, the technical revolution, without forfeiting its own basic characteristics. Nevertheless, the action and counteraction between the two has given rise to formidable problems. It is essential, therefore, in facing the problems of free men, to have a clear idea of just what the technical revolution is. The United States has contributed many inventions to the technical store but its greatest and most enduring contribution has been in assembling and organizing inventions to mass-production ends.

MINNESOTA'S NATURAL GIFTS

The American way of life and technological advancement in this country are well represented and illustrated by the industries in the State of Minnesota. This great state has an area of 84,068 square miles and ranks eleventh as to state areas in the United States. It was the thirty-second state to be admitted to the Union. It has a population, according to the 1950 census, of 2,967,210. The principal cities of this great state are, of course, Minneapolis, Saint Paul, and Duluth. I would say, from what I have read and seen, that Minnesota is keenly alive to industry and to the health and happiness of its citizens. Certainly the existence of more than 11,000 lakes, with parks and recreational facilities throughout the state, should keep its population happy. I am keenly aware of that God-given gift which is theirs. Being a Californian, I am somewhat envious of the water that you are provided with.

Minneapolis owns 131 parks covering 4777 acres, of which about 1000 acres are outside the city limits. The system embraces a playground or neighborhood park for every square mile of residential area and more than one acre to each hundred of your population. The mighty Mississippi has its source in Minnesota. From a geographical standpoint it is interesting to note that at the close of the Revolution, the Treaty of Paris was supposed to establish the northwest boundary of the United States and defined it as passing through Lake Superior to the long lake, thence through the long lake to the Lake of the Woods. Later, however, no one was able to determine which lake was the long lake for the reason that any lake in Minnesota, for instance, that was not round would have to have a dimension that is longer than it is wide. However, to settle the dispute, Daniel Webster and Lord Ashburton conferred in 1842, and acknowledged that Old Grand Portage or the Pigeon River, to which it gave access, would make a reasonable compromise and this settled the boundary at this point. The British failed to guess that in settling the boundary the chief source of iron in the New World, the Mesabi iron range, would lie in the United States. Furthermore, the northern boundary of Minnesota, known as the Northwest Angle, is the most northern part of the United States exclusive of Alaska.

Minnesota is known throughout the United States for its justly famous Minneapolis Symphony Orchestra and likewise known for the world-famed Mayo Clinic of Rochester. I think that almost any person requiring an operation thinks longingly of going to the Mayo Clinic.

The University of Minnesota is far-famed, and this year it is celebrating its hundredth anniversary as the University was founded in 1851. This famed University has an endowment of $33,000,000. with a student enrollment of 25,343 and a faculty of 3711, which means that there is one instructor or professor for every seven students. Our Society has maintained a student branch at this University since 1913, and the same year the Minneapolis and the Saint Paul Sections of our Society were organized, the two sections merging in 1934. The last official list of membership shows that the Minnesota Section has 313 members.

As I previously stated, the industries in Minnesota well illustrate the American way of life as I have previously here defined it, according to my concept.

LUMBER, WOOD PRODUCTS, AND AGRICULTURE

Minnesota is the home of Paul Bunyan, the mythical giant lumberjack who logged two townships at a time, uprooted trees in order to comb his beard, and had his camp griddle greased by boys using sides of bacon as skates. There is some doubt as to the origin of this mythical hero. According to some people, the legends are of Canadian origin. In any case, the legend is said to have begun in the Papineau Rebellion in Canada in 1837, when a mighty muscled, bellicose, bearded giant named Paul Bunyan raged among the Queen's troops like Sampson among the Philistines. The subject of Paul Bunyan naturally brings us to the subject of lumber and wood products which have been developed in Minnesota.

To show the importance of lumber, there are 408 establishments, not including furniture, having to do with lumber and timber basic products, millwork, and prefabricated wood products; there are 113 furniture and fixture manufacturing companies, and 56 paper and allied products manufacturing companies, one of which is the well-known Minnesota and Ontario Paper Company.

Trees of course are important because wood is one of the world's greatest storehouses of chemicals, such as cellulose, lignin, sugar, resin, gum, and waxes. The clearing of lands of tree stumps gave rise to an industry which developed a machine having immense V-type blades 16 feet on a side which cut swaths 10 to 12 feet wide through thickness of elm and pine at 3 to 6 miles per hour. This machine is capable of cutting trees and stumps at the rate of 2 acres of land per hour. Today lumber is a $90,000,000 a year industry.

Agriculture is perhaps the chief industry of Minnesota. The state produces great crops of corn, wheat, potatoes, hay, oats,

barley, and other grains. Minnesota is one of the leading dairy states. In fact, it is known as the butter state. More than 33,000,000 acres are devoted to farming, and in the 90 years of Minnesota's agricultural history there has never been a general crop failure. In 1947, Minnesota produced on her farms 197,000,000 bushels of corn, 227,000,000 bushels of small grains, more than 14,000,000 bushels of potatoes, and 14,000,000 bushels of soy beans. The total cash farm income for that year was more than $1,330,000,000. Minnesota ranks second in the production of poultry and poultry products and oats, and third in turkeys; fourth in corn and barley, and seventh in alfalfa seed. Dairying, and the raising of livestock and poultry are the most important Minnesota industries. The South Saint Paul stockyards rank among the first three livestock marketing centers in the United States. The state is second in the production of milk and milk powder. The Land o' Lakes Creamery Association, with headquarters in Minneapolis, is the largest co-operative creamery association in the world and operates a number of big creameries in various towns in the state.

Speaking of agriculture, it is well to mention such companies as The Minneapolis-Moline Company. This company manufactures farm tractors and all types of farm equipment. Warren C. Mac Farlane, president of this large company, is an ASME member. This company has shown a remarkable growth and has grown steadily in size from 1941 to 1950. The only off years, where growth decreased slightly, were 1945 and 1946. Its sales in 1941 amounted to $23,000,000 plus and in 1950 to $79,000,000 plus. Every type of highly developed farm implement is manufactured, such as harvesters, tractors of different models, together with combination harvesters, huskers, and balers, of a type which picks up, ~~bales,~~ and wire-ties. The tying of the bale is done in a very novel manner in $3^1/_2$ sec with a special type of wire knot which does not come apart when the wire is cut.

It is interesting to note the number of farms in the State of Minnesota that use tractors. In 1930 the number of farms per thousand using tractors was 249.2 but by 1945 the number had increased to 681.2, a percentage increase of 173.4 per cent. During that time there was little change in the average size of the farms. In fact, between 1930 and 1945 the percentage increase was only 5.1. However, there was a notable increase in the per-capita income, and between 1929 and 1948 this per-capita income increased 139 per cent.

MINING INDUSTRY

An important industry in Minnesota is that of the mining of iron ore. Minnesota has several sources of iron. The chief one, however, is a range 90 miles long and 2 to 10 miles wide, known as Mesabi, the word being Chippewa Indian for "giant." It was J. A. Nichols of Duluth who on November 16, 1890, dug a test pit which yielded hematite, which was 64 per cent iron. This discovery was made just north of the present Mountain Iron Mine. Iron had been struck on the Vermilion Range in 1865 but required underground mining. The third iron range is the Cuyuna. When World War II made demands for iron, these three ranges delivered 75,000,000 plus tons in 1942.

Most of the ore comes from what is known as an open pit, and Hibbing has the world's largest open-pit iron mine. From this mine close to half a billion tons of ore have been hauled out on the mine's 55 miles of railroad track. This pit is $3^1/_4$ miles long and at one point is a mile across. This particular mine is operated by the Oliver Mining Company, a subsidiary of the United States Steel Corporation.

The importance of iron and steel is known to all of us. We know that military accomplishments of world supremacy depend upon steel; and if all the iron and steel in use in this country were divided equally among its 153,000,000 inhabitants, each man, woman, and child would have more than 17,000 lb.

Even the small American home contains 8000 lb of iron taking into account the stove, washing machine, ironer, sink, bathtub, washbowl, nails, hardware, and the like. Then there is the family automobile which contains 125 different kinds of steel. The average passenger car requires 3400 lb or more of steel.

I mentioned specifically the Oliver Mining Company which has its headquarters in Duluth. Mr. Rudolph T. Elstadt, president of the Oliver Iron Mining Company, in an address before the Minnesota Junior Chamber of Commerce, Saint Paul, earlier this year, stated that the iron-mining business provides about 15,000 people with steady jobs in the mines and plants, which means the employment of another 30,000 providing services in our mining community. He stated that in 1950 the payroll of the mining companies totaled $50,000,000. In the case of the Oliver Mining Company, the railroads alone for this company require 105 locomotives and over 400 cars. One of the interesting devices used by it is a huge conveyer belt, over $^1/_4$ mile in length, which hauls ore from the pit to a railroad station. The ore is lifted over 40 stories from the mine to the surface.

Iron mining in Minnesota is big business because 84 per cent of all iron ore produced in the United States comes from the Lake Superior district. It is also big business because of the taxes levied. Last year the mining industry paid $35,000,000 in taxes. The shipments of Minnesota iron ores up to the end of the year 1950, have been 1,874,000,000 tons.

Mining of iron ore has produced many problems to be solved by engineers, such as the effectiveness of concentrating methods, the production of tromels, logs, turbos, jigs, classifiers, crushers, sizers, hydrotators, driers, heavy media, gravity, flotation, and magnetic roasting. There are 58 concentrating plants operating in Minnesota as of 1950; and the University of Minnesota established the Minnesota Mining Experiment Station. At this station private plant tests have been run on new equipment that has been installed over the years. Tests have been made on grinding problems, magnetic separation, jigging, high-density methods, and many other aspects of mining. Minnesota is developing methods to extract iron from taconite.

Taconite, as is well known, is a low-grade hard rock containing about 25 per cent iron. The iron ore which is mined normally is high grade and contains about 51 per cent iron. However, a problem is presented in the case of taconite. Millions of dollars have been expended in attempting to obtain iron from taconite, one of the chief difficulties being to eliminate the silica from the rock. Generally the method consists in crushing the rock as fine as cement by a series of crushers, bringing the rod mills to 8 mesh, whereupon it is passed through magnetic separators, thence to classifiers, then ball mills which grind it to 100 mesh, then through magnetic separators into filters, balling drums, and into a pelletizing furnace which provides pellets which are 64 per cent iron. This is most remarkable when we realize that taconite in its unmined state may contain from 25 to 30 per cent iron and the recovered product 60 to 65 per cent.

A taconite plant requires a large investment—from 15 to 25 million dollars for each million tons produced annually. Hence for an annual production of 30,000,000 tons, the investment is between 450 and 750 million dollars. In the case of taconite, because 70 to 80 per cent of the concentrate is more than 325 mesh, a new process of agglomeration was developed at the mine's experiment station at the University of Minnesota. Professor Joseph, the assistant dean of the School of Mines and Metallurgy of the University of Minnesota, wrote me that it would require a number of years of study and power-plant

operations to establish the best treatment, including agglomeration, and reliable operating costs.

Among the companies attempting to develop a knowledge of iron production from taconite through research, the Oliver Mining Company has erected a new $20,000,000 plant for this purpose. This is another indication of the American way of life, for it requires a large accumulation of capital to make iron and steel, develop mines, build railroads, and to provide a great fleet of boats to carry the ore. Certainly the individual is ill-equipped to spend half a billion dollars in new plants and processes. However, all of these corporations are faced with a problem because of the high taxes levied against them, and I understand that in the state of Minnesota the occupation tax paid on a dollar earned in iron mining is about $3^1/_3$ times the state income tax upon a dollar earned by other corporations in Minnesota. This to me is very alarming when we realize that two thirds of the entire income of the United States is now being paid in taxes.

The late Charles V. Firth of the Mines Experiment Station of the University of Minnesota developed a method for the production of iron powder from iron carbonate slate with a purity of over 99 per cent. The powder, however, is quite expensive in the pure state, being around 40 cents per lb. However, this powder is capable of being compacted under great pressure in a die through a method more or less of the type used for the molding of plastics. After the pressure operation the part is sintered in an electric furnace. Great savings result, particularly when the part is intricate in shape and would require much skilled machining. This method is adaptable for parts for machine guns, antiaircraft weapons, precision gages, and the like.

A great deal of work along this line has been performed by Continental Machines at its power plant at the eastern end of the Mesabi range near Aurora. The method used, as I understand it, consists in crushing the ore, then milling it to a fine sand, and then dissolving in an acid to separate the iron from impurities. The relatively pure crystals of iron sulphate are prepared by a series of filtering, evaporating, and crystallizing operations. The crystals are further purified by roasting which changes the iron sulphate to red iron oxide but leaves the impurities in such form that they may be washed out of the iron oxide. This red oxide is over 99 per cent pure. It is then fed through furnaces in which it is reduced to pure iron by contact with gas made in the plant from coke.

TRANSPORTATION FACILITIES

Mined iron ore requires transportation. The city of Duluth is strategically situated on Lake Superior and ranks second to the port of New York in the amount of tonnage handled by its harbor facilities. The second great waterway is, of course, the Mississippi River. The Empire Railway Builder, James J. Hill of Saint Paul, Minn., built the Great Northern Railway Company which opened the whole Northwest. The Great Northern and Northern Pacific still have their headquarters in Saint Paul. In fact, Minnesota has eight major railroads, 83 truck lines, and five trunk air lines. We all know of the Northwest Air Lines at Saint Paul. It is also interesting to note that the Greyhound Bus System was built in Minnesota, a system that crisscrosses the entire United States.

Minnesota is blessed with great deposits of peat. I say "blessed" because Minnesota does not have any coal. For fuel purposes it is found that 2 tons of peat are equivalent to 1 ton of good coal, and it has been estimated that Minnesota has 7 billion tons of bog peat. However, the processing of this peat is an engineering problem, particularly when economical methods are considered for its production as an industrial fuel. Mr. Odin A. Sundness, manager of the Snyder Mining Company, developed the Sundness Process for the treatment of peat.

UNIVERSITY OF MINNESOTA HYDRAULIC LABORATORY

The Hydraulic Laboratory of the University of Minnesota, known as the Saint Anthony Falls Hydraulic Laboratory, is under the directorship of Prof. Lorenz G. Straub, a member of the Society. In a letter to me from Mr. Straub he pointed out that the Saint Anthony Falls Hydraulic Laboratory has the unique place in its particular bailiwick of service. Its services in research and experimental design problems are distributed geographically throughout the United States and to some foreign countries. On its staff as assistants are persons from many foreign countries. Thus, represented in the current year, are staff assistants from France, England, Austria, Sweden, Australia, India, Italy, China, Palestine, Germany, and Canada. Graduate students, specializing in fluid mechanics and hydraulics, come here to study from all parts of the world.

Continuing with the subject of research, it was at the University of Minnesota that Dr. Wallace D. Armstrong, together with Dr. John W. Knutson of the Public Health Service, discovered that in children, tooth decay could be reduced about 40 per cent by painting them with fluorine.

The university is noted for its cancer research, of which Dr. John J. Bittner is director of the University's Division of Cancer Biology. Research is very active in aeronautics and the university has what is known as the Rosemount Research Center. The wind tunnel is capable of wind velocities up to 5000 mph.

Minnesota has many famous food producers, such as General Mills, which turns out approximately 42,000 sacks of flour a day; Pillsbury, which concern is well known for its A-1 flour and other products, Russell Miller, Commander Larrabee, International, and others; in fact, this is the home of Cream of Wheat. Sixty tons of butter daily are delivered by the Minneapolis plant of the Land o' Lakes; the well-known firm of Hormel is located in Minnesota at Austin. The well-known Spam originated here, and the Hormel Institute, a unit of the University of Minnesota, is doing research in biology and chemistry. Some of the country's most important packing centers are in South Saint Paul and Austin. As pointed out previously, the South Saint Paul stockyards rank among the first three livestock marketing centers in the United States.

THE MAYO CLINIC

The famed Mayo Clinic is of course known throughout the land. It was founded by Dr. William W. Mayo at the request of the Sisters of the Order of Saint Francis. Dr. Mayo was joined by his two sons, William J. and Charles Horace Mayo. From a small beginning the present Saint Mary's Hospital was built, and the Clinic is now headed by the grandson of the original Dr. Mayo, Dr. Charles W. Mayo. The Mayo Foundation is affiliated with the University of Minnesota.

At the present time Ellerbe & Company, architects and engineers of Saint Paul, are engaged, according to William Sturm, their chief mechanical engineer, in constructing the new Diagnostic Clinic Building for the Mayo Clinic in Rochester. This is a $12,000,000 project and will be completely air conditioned. The specific structural design is under the direct supervision of Elza Gardner, chief structural engineer of Ellerbe & Company, and employs high-tensile bolted structural-steel framework, and makes use of the development and test data provided by the American Institute of Steel Construction and the Structural Department of the University of Illinois.

The method used to handle the wind loads differs from the customary practice of designing a single joint or bent. The sum of the wind resistance was computed for all members and joints in the structure contributing to wind resistance. The wind load was distributed in proportion to the relative stiffness of members and elasticity of joints. The final stress was then

determined by moment distribution. New in this structure is the application of orificing vertical ventilation and air-conditioning duct risers. This orificing is necessary to prevent floor-to-floor air-delivery quantities from varying with changes in atmospheric conditions.

Of interest is the fact that the Sister Kenny Institute has its headquarters in Minneapolis for combating the crippling effects of infantile paralysis.

OUTSTANDING INDUSTRIAL CONCERNS

I want to mention specifically the General Mills. While this company is widely known for flour milling, still it has activities in other directions, such as the processing of vegetable oil. The famous "Betty Crocker" kitchen is a General Mills institution. However, in addition to the milling industry, General Mills has established a manufacturing division and has brought out a line of household appliances, flatirons, and the like. It has a research department which has developed many products used in the field of aeronautics. It developed and constructed the well-known balloons which were called Flying Saucers, and the balloons which are being released to float over the Iron Curtain carrying printed matter is its product. General Mills has developed a sizable chemical industry and is now producing a variety of chemicals on a large commercial basis. It has a fatty-acid plant at Kankakee, Ill., and an amino-acid plant at Keokuk, Iowa, which utilizes wheat protein as a basic source of amino acids.

A second company that I wish particularly to mention is the Minnesota Mining & Manufacturing Company, which has grown from a small sandpaper factory to one of the largest producers of tapes and adhesives in the country. We all know that Scotch cellophane tape, and industrial masking tapes of all types are among the major products of this company. Its Scotchlite reflective material is well known for signs which light up at night when headlights hit them.

Since the end of World War II the company has invested more than $55,000,000 for plant expansion. This money has been used for more than thirty separate projects throughout the country, and substantial amounts have been authorized for projects, some of which are already under construction. The engineering department of this company is under the direction of C. P. Pesek. The company has produced its new fluorocarbon process from the laboratory beaker stage to the commercial production stage in 4 years.

Minnesota Mining & Manufacturing Company has pioneered this phase of electrochemistry and is operating in unchartered territory which made it necessary for company engineers to design much of the equipment used in the plant. Dr. James L. Hendricks, assistant director of the Central Research Laboratory, delivered a paper before the American Chemical Society in New York during its Diamond Jubilee, entitled, "Industrial Fluoro-Chemicals."

A few years ago the structure of the Minnesota Mining & Manufacturing Company was revised to provide an industrial-division setup, and at the present time it has ten, such as tape, coated abrasives, adhesives and coatings, roofing granules, and so forth. Each division has its production, sales, and office force, and is under the direction of a company vice-president or general manager. The system enhances co-ordination of research, engineering, and production efforts, so as to eliminate duplication of engineering effort, and insures that any improved production technique developed in one division whenever possible will be adopted quickly by the other divisions. This company grew from a $20,000,000 sales volume in 1940, to $152,000,000 in 1950.

Another great company in Minnesota is the Minneapolis-Honeywell Regulator Company. Briefly, a résumé of its recent engineering development includes electronic moduflow, electronic humidity control, electronic combustion safeguard, light control, servomechanisms, fuel gages, and cabin temperature control for high-speed, high altitude aircraft. I had the pleasure of reading Ralph Wallace's article entitled, "The Merlins of Minneapolis," and I quote freely from this interesting article. The Minneapolis-Honeywell Regulator Company has scientists who at the present are revolutionizing map making with an electronic device which measures distances with an error of less than 10 ft for every 300 miles. This company is the world's largest manufacturers of thermostats and other home-heating controls.

The company is responsible for the development of the automatic pilot which is standard equipment in all United States heavy bombers and was credited by the Air Force for increasing wartime bombing accuracy by the staggering figure of 40 per cent. At the present time the company lists more than 8000 different controls in its catalog.

Minneapolis-Honeywell has two chief plants, the Minneapolis-Honeywell Regulator Company, in Minneapolis, and the Brown Instrument Company in Philadelphia. The company in Minneapolis is planning, through its scientists, refinements of complex blind-landing systems, air heating, and the like. It was Minneapolis-Honeywell that developed a humidity control for hospitals to prevent the explosion of anesthetics in operating rooms.

It was Minneapolis-Honeywell that developed some of the most spectacular scientific devices for World War II, such as the detection of submarines by electrical means—devices which aided in the discovery of the submarines. Another outstanding development of Honeywell is the automatic pilot known as the Honeywell autopilot which was immediately accepted by the Air Force and was one of the outstanding aeronautical inventions of the war. Bombing accuracy was increased, roughly, 40 per cent and the time necessary to hold a plane in the bombing run was cut 80 per cent. In the early days of the war, for example, a Japanese-held bridge near Bangkok had been bombed by from 12 to 16 heavy bombers seven times in succession without a single hit; with the installation of Honeywell autopilots, four planes destroyed the bridge completely in a single raid. From Pearl Harbor on, more than 35,000 such electronic pilots, one for every heavy bomber was used in the war. The atomic bomb of Hiroshima was dropped with deadly accuracy by the same device.

Minneapolis-Honeywell and the Radio Corporation of America worked together on what is known as the Shoran project. This consists of a pair of radio transmitters and receivers and an electronic computer put together in a bombing plane. RCA developed the radio devices and Honeywell the computer. With this device accurate bombing is possible.

In addition to this well-known development, the electronic autopilot and Shoran, the company also created the electronic fuel gage; a cathode-ray electronic compass; a formation stick tied into the autopilot's ailerons and rudder motors to permit effortless one-hand formation flying in turbulent air; a cabin-pressurizing system for the B-29; and an electronic device which controls speeds on the turbosupercharger.

Honeywell has developed an industrial control for steel. One of the industry's greatest problems has always been the life expectancy of open-hearth furnaces. Extremely low-carbon steels are finished at 3000 F, only 50 F under the melting temperature of the roof of the furnace itself. Until a few years ago, no method of measuring roof temperatures existed. Any known instruments would melt on contact with the almost molten roof surface. The Brown Instrument Company developed the radiation pyrometer, and roof temperatures can be read to within 5 F plus or minus, with the result that offi-

cials of the U. S. Steel Company state furnace life has been increased at least a third by the new instruments, effecting a saving of $2,500,000 yearly for that corporation.

CONCLUSION

Minnesota has the greatest medical clinic, the Mayo Clinic, the world's three largest flour-milling companies, the world's largest calendar publishing organization, the Brown & Bigelow Company, the world's largest law-book publishing company, the West Publishing-Company. In addition, Minnesota has the world's first carp canning plant, the world's first burbot liver-oil processing plant, and the world's largest savings and loan association, all of which speaks very well for the State of Minnesota.

ACKNOWLEDGMENTS

I wish to make the following acknowledgments as the source of material concerning Minnesota and its industries:

The Secretary of Commerce, the Hon. Charles Sawyer; United States Senators Hubert H. Humphrey and Edward J. Thye; the *Minneapolis Star*, by Mr. Arthur R. Upgren, associate editorial editor; Ellerbe & Company, architects and engineers, by Mr. William Sturm; Toltz, King & Day, Inc., engineers and architects, by Mr. W. E. King; Helen Powers Service Corporation, by Mr. W. Lyle Burst, general chairman; Minnesota Mining & Manufacturing Company, by Mr. L. S. Whitson. Mr. Burst is chairman of the General Committee of the 1951 Fall Meeting in Minneapolis, and Mr. Whitson is on the Reception Committee. Acknowledgment is also made to Mr. C. P. Pesek, vice-president of the Minnesota Mining & Manufacturing Company; to Mr. J. W. Malmquist, director, industry division, department of business research and development, Minnesota; to Dr. Ralph H. Manley, director of research, General Mills, Inc.; to the Oliver Iron Mining Company, by Mr. Joseph H. Jordan, director of public relations; to Victor Roterus, chief, Area Development Division, United States Department of Commerce, Washington, D. C.; to the Saint Paul Association of Commerce; the United States Chamber of Commerce; the University of Minnesota and specifically to Dr. Malcolm M. Willey, vice-president, Academic Administration; Dean A. F. Spilhaus; Dr. E. M. Kemler, professor of mechanical engineering; Dean T. L. Joseph, assistant dean, School of Mines and Metallurgy; Prof. Lorenz G. Straub, director, Saint Anthony Falls Hydraulic Laboratory; Prof. Henry E. Hartig, professor and head of the department of electrical engineering; Prof. Richard C. Jordan, head, department of mechanical engineering; to the Minneapolis-Moline Company; to the Minneapolis-Honeywell Regulator Company and Mr. James H. Porterfield, head of public relations for that company; the Minnesota Mining & Manufacturing Company, by Mr. John Verstraete of public relations.

The material and the co-operation received from the companies and the persons whom I have just enumerated were most heartwarming and gave me an insight into industries in the State of Minnesota that is up to the minute. All of the gentlemen named and their respective companies co-operated fully.

Environment Laboratory

THE American Society of Heating and Ventilating Engineers unveiled its new Environment Laboratory, in Cleveland, Ohio, recently. The laboratory will be used to study human comfort in heated and cooled indoor spaces and to develop data for the design and installation of panel heating and cooling systems.

It is a large room in which the temperature of all the room surfaces and portions of each surface can be controlled separately so that it is possible to simulate a variety of combinations of cold and warm walls, windows, floors, and ceilings. For example, to simulate a corner room of a building, two walls can be cooled to the desired temperatures, while some of these walls can be held at a lower temperature to simulate glass areas.

So that the room could also be used for a study of the relationship between human comfort and radiation, it was designed to permit division into two rooms when desired. At present the room is not yet an environment laboratory in the fullest sense. Additional equipment will have to be provided and some fundamental changes made after the completion of panel-heating studies to make it suitable for physiological studies.

The room is approximately 25 × 12 ft, with a ceiling that is adjustable to heights from 7 to 12 ft. When divided in two, each room will measure 12 × 12 ft. The outer shell is of $^3/_4$-in. plywood on a light steel framework. The floor is three feet above the floor of the main ASHVE Laboratory (in which it is housed) to provide a crawl space for piping and wiring.

All interior surfaces of the room are formed of aluminum panels. Attached to the back of these panels are $^3/_8$-in. copper coils on 3-in. centers, connected to mains in the crawl space.

The room has been designed to permit surface temperatures which may be encountered at outdoor temperatures as low as 0 F. Cold-wall areas can be maintained at temperatures as low as 40 F; simulated glass areas as low as 20 F. Floor and ceiling surfaces can be kept at any temperature up to 180 F.

Air can be supplied at simulated outdoor temperature for studying the effect of infiltration. Two changes per hour of air down to 0 F can be supplied to the room at simulated window locations. This air is treated in a sorption-type dehumidifier and cooled to simulate dry outdoor air. The same system also furnishes dehumidified air to the crawl space and to the space between the wall panels and the outer shell to minimize condensation behind the panels.

The refrigeration compressor, heat exchangers, tanks, pumps, and miscellaneous equipment necessary to supply liquid to the various panels are located in the lower ASHVE Laboratory immediately below the room. Separate pumps and piping systems are provided for the ceiling, floor, simulated cold-wall areas, and simulated glass areas.

The instrumentation provided will permit the following readings: (1) Surface temperatures within the room by means of almost 400 thermocouples attached to the back of the panels; (2) air temperatures at any point in the room; (3) the rate and temperature at which the infiltration air is supplied; (4) how much heat is picked up or given off by all surfaces. This is measured by means of 175 heat flowmeters, $11^1/_2$ in. sq which were fabricated at the ASHVE Laboratory of bimetallic foil separated by plastic spacers.

Other instrumentation will be added to determine mean radiant temperatures, air velocities within the space, and the flow of heat from the air to any surface or vice versa.

Equipment will be added later which will permit maintaining air temperatures within the room independent of surface temperatures. This will permit the human-comfort studies under varying internal dry-bulb temperatures, relative humidities, and air-change rates.

SERVICE, MOTIVATION, *and* SUPPORT[1]

By H. S. ROGERS

IN my report[2] for the year 1950–1951, I endeavored to focus the thinking about ECPD by all members and officers in our sponsoring bodies upon a concept of ECPD as an intersociety, intraprofessional body. As such a council, ECPD undertakes to aid young men seeking induction into the engineering profession, and those training for it in their growth and development until they have reached the level of full recognition. In order more effectively to focus attention and efforts upon certain areas in such a comprehensive concept, a revision of the Charter and the Rules of Procedure were presented at our last annual meeting by a special committee, and adopted by the Council. The Charter was then presented to the governing boards of our sponsoring societies and has since been approved. It is therefore now in effect. The Rules of Procedure became effective by action at that annual meeting.

Under these rules a new Student Development Committee and the former Committees on Ethics and on Information were added to the standing committees. The special Committee on Unity which was appointed in the previous year continued in office and during the current year a subcommittee of the Education Committee on adequacy and standards was appointed to study the conditions currently existing in engineering education. We have, therefore, at our annual meeting this year reports from all of our standing committees, with the exception of the Student Development Committee, and from the two special committees—one on unity and the other on the standards and adequacy of engineering educational programs.

Because the Student Development Committee was conceived under the new Rules of Procedure for the purpose of undertaking services in an area in which we had not previously operated, it was necessary for the Executive Committee to take some time to explain the contemplated work to our participating boards and to secure a qualified and interested personnel. The committee has now been manned with people of vision, ability, and experience, and it will initiate the study of problems and single out those tasks which need immediate attention in its area. We have not, however, called upon it for a report at this annual meeting.

Throughout the year the Executive Committee through its bimonthly meetings has worked with the standing committees to point up the objectives, to help in the framing of the programs to man the operations, and to aid in the direction and the continuity of our service. In this manner, all representatives of our constituent bodies have followed the work closely and have participated in it earnestly.

GUIDANCE COMMITTEE

The Guidance Committee under the direction of Willis F. Thompson has developed a plan and a program to cover the nation with a network of state committees to disseminate information on sound and effective methods for guidance in engineering and to work with those agencies which are currently undertaking service in this general field. It plans to disseminate information and literature which may be advantageous in guidance, and to arouse and to stimulate practicing engineers who are qualified to advise high-school students on the operations and requirements of, and training for, the engineering profession. The manner in which this has been done is presented in the committee report. It is anticipated that this work will be cumulatively more effective throughout the years ahead.

The development of the Pre-Engineering Inventory which was sponsored by ECPD and largely financed by the Carnegie Foundation has been carried forward by the Educational Testing Service with the aid of an advisory committee consisting of the president of ASEE and the chairman of ECPD, together with the chairmen of the guidance committees of both organizations. The guidance committee of ASEE is presently undertaking to exercise all the responsibility pertaining to its use in the engineering schools. This has placed the supervision of this service used by one of our sponsoring bodies where it obviously belongs.

EDUCATION COMMITTEE

The Education Committee has continued its very effective work in the field of accrediting and its achievements are presented in the annual report. It has as usual enlisted the loyal service of many engineers throughout the country. During the year it has co-operated with the National Commission on Accrediting by explaining the objectives and procedures of its work and the needs and conditions which caused the engineering profession to establish this service. Its work is constantly reviewed both with regard to policies and operations.

A discussion of the present status of the engineering educational programs at one of the executive-committee meetings prompted the appointment of a subcommittee on adequacy and standards in engineering education for the purpose of making a preliminary review of the conditions existing, and determining what, if any, action should be taken. A progress report indicates that the work of this subcommittee may be a most important feature of ECPD's services in the future.

PROFESSIONAL TRAINING

Last year the Committee on Professional Training presented a comprehensive description of a program designed to aid young engineers in the first five years of professional development. It pointed out the interests of industry, of the colleges, and of the engineering societies in this development and highlighted the responsibilities of each. It proposed that young engineers although accepting the final responsibility for their own professional development should be aided in six areas where ECPD might promote the right type of training, of indoctrination, and of self-analysis. It presented examples of orientation and in-service training, continued college education, introduction to community service, indoctrination in characteristics, responsibilities, and ethics of the profession leading to recognition through registration, self-appraisal for the purpose of orienting personal plans, and of selected reading for professional and personal growth. The report was enthusiastically received and several hundred copies were distributed.

To implement it the committee proposed that an extension director be employed for the purpose of organizing the resources and agencies which might help in establishing programs in a number of chosen communities. After appraising the needs of interested industry, the resources of the professional societies and of the colleges of a particular area, this field director, it was contemplated, would assist in tailoring a program to the needs of the particular area. It was estimated

[1] The Chairman's Report to the Engineers' Council for Professional Development.

[2] Mechanical Engineering, November, 1950, pp. 895–896.

that a total of $20,000 per year would be required to finance this, and an effort was made to raise the amount. Approximately $3000 was included in the supporting grants from our participating societies. The ASME and AIEE each pledged $3000 and the Engineering Foundation appropriated $5000 which was made available on the basis of one to three of other contributions. Other efforts to secure additional funds have to date been unproductive. There is, however, a high hope that enough can be raised to initiate this program at an early date. It is the firm conviction of the Council that once there is an opportunity to demonstrate such a program the difficulties of raising continuing support will rapidly decline.

The experience in initiating this work brings into retrospect the original program set up by ECPD in its early years under General R. I. Rees which was supported by a grant from the Carnegie Corporation. This early program was brought to an end by the untimely death of the General. Since that time the activities of the Training Committee have been focused pretty largely upon the publication of information useful to junior engineers in promoting their own courses of development. The implementation of this suggested program is one of the major responsibilities currently before us.

RECOGNITION COMMITTEE—OTHER COMMITTEES

At the last annual meeting it was suggested that in the development of the concept that ECPD would be responsible for the inter-society, intraprofessional interests of the engineering profession, the Recognition Committee should offer its services to the NCSBEE and the ASCE for the purpose of keeping the model law up to date and suggesting revisions as they might seem necessary. Both the NCSBEE and the ASCE have agreed to co-operate and the committee expects to undertake the leadership necessary to provide constant supervision of this interest.

The committee reports that the American Society for Engineering Education grades of membership conformed to the uniform grades and as a result of the recent vote the AIEE has amended its constitution to comply with the recommendations.

The Information Committee has done an excellent job in reviewing and editing all publications of the Council and is supervising revisions and distribution of these in a most effective manner. The Committee on Unity is co-operating with the Exploratory Committee of the Engineers' Joint Council and keeps in constant touch with their studies so that the function and place of ECPD among our professional services will be given adequate consideration.

The present program is conceived and designed to take the work of the Guidance and Training Committees out of the "talk about" stage into the stage of effective action. The efforts and voluntary services required to accomplish this must in the future be as great as those which have been contributed to the work of the Education Committee in the accrediting of engineering schools. While the programs under the Student Development and Recognition Committees may not be as extensive as the former two they, nevertheless, need the attention and services of equally devoted and self-sacrificing members of the profession.

There seems now to be general agreement as to the nature and scope of the work undertaken by ECPD. The program is adequately designed to achieve the objectives set forth in our charter.

THE FUTURE

The matters of primary concern in the coming year seem to be a recruitment of professional personnel into the work of the Council and the raising of funds for the training program. ECPD occupies a place in the common personal interests of the engineering societies in many respects similar to the place which a community service organization devoted to the public interest occupies among commerce and trade associations devoted to specific interests of a large city. Engineers belong to specialized professional societies because of the opportunity to contribute and to receive knowledge about the advancements and developments of the particular arts and applied sciences in which they have a personal interest and because of the opportunity to be associated with and receive advice from the learned minds of the professional. Membership in such groups as the Founder Societies has a great deal of value in their daily professional operations. There is a quid-pro-quo and a pride in such a membership which commands their allegiance, loyalty, and devotion. On the other hand, the program of ECPD, while it may give an indirect return to society members, is more particularly a service program to the juniors of the profession. In this respect it must command a self-sacrificing interest from mature professional people. The motivation must be primarily a motivation of service. To carry out our program, therefore, we must find, through our supporting societies, more persons—and there must be many more—who have an earnest desire to help in a situation in which the returns may have no immediate professional significance to them.

In seeking suggestions from our participating boards for the purpose of manning our committees and executing our tasks, it is surprising how repeatedly the same names are offered and how much a relatively small group of our professional people do. Every effort must be made by our supporting bodies to broaden the number of those who are contributing to the services of ECPD for the long-range advancement of the engineering profession.

Last year I asked if our constituent members wanted the kind of program which we were presenting in order to carry out the purposes of the charter which they had framed. The response as evidenced by the support given was clearly in the affirmative. It must, however, be recognized that if the current program is to be carried forward a growing need for funds will ensue. Some of these funds should in all propriety be raised by the Council itself; lesser amounts will be required from the participating bodies. Those required in the latter category, we believe, will not be difficult to secure if the officers and members of our participating groups are informed about our purposes and achievements. We urge boards of directors, committeemen, and staffs of all societies to attain an understanding of ECPD and its services and to lend their aid by widely disseminating this understanding to their members.

ACKNOWLEDGMENTS

In concluding this report I desire to acknowledge for myself and for the Council the generous and self-sacrificing help which has been given to us by The Engineering Foundation, by our constituent bodies, and by the many members of the committee who have served so devotedly and enthusiastically.

The support of The Engineering Foundation that has been granted for our general operations has for years been a great benefaction to ECPD. The special grant of $5000 to support The Professional Training program, although not taken up, was greatly appreciated. The voluntary extra contributions of $3000 from both the ASME and the AIEE gave evidence of confidence in the work of the Council which was very heartening, as were also the very substantial contributions from the state boards of engineering examiners.

The standing and special committees are all working earnestly and effectively as each has taken up its tasks with interest and devotion. A growing comprehension of, and morale in, the service of ECPD is yearly gathering momentum and augers well for the future.

ON RESOLVING CONFLICTS[1]

By HERBERT A. SHEPARD

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

"ROADS to Agreement"[2] is a book of cases selected for the help they give in answering the question: What techniques are known for lessening conflict and promoting agreement? Although the book was inspired by "the natural anxiety of a citizen, watching the spiraling disagreements of the cold war," Chase did not set out in search of a grand formula to solve this greatest problem. His goal was more modest: to find a man "who has learned to get on with his fellows and can tell us how he does it."

Before setting out on his journey, Chase pauses to look into what he calls a "skyscraper of conflict," showing the various levels—from interpersonal to international—at which destructive conflict rages. "A fight on every floor." This dismal scene is followed by a brief inquiry into the origins of conflict. He finds the most serviceable theory to be that frustration (and the threat of frustration) in the pursuit of goals produces the aggression necessary for a good fight.

At this point the author might have led directly into his central theme by pointing out that the heart of the problem is not the aggression itself, but the target of the aggression. His original question might be rephrased: What techniques are available for channeling the aggression of mutually frustrating parties into an attack on the common problem of scarce resources rather than an attack on one another?

Instead of this direct approach, we find a chapter entitled "Solid Ground" which turns out to be a somewhat shaky bridge to the mainland of the book. The bridge is built of three "natural offsets" to conflict. The point seems to be that these offsets are present in all situations as forces tending to bring the parties to agreement. However, the point is not clearly made and its validity is doubtful. The first offset is the observation that argument usually precedes agreement. In a sense, this is true by definition. If there were no differences, there would be no question of resolving them. The second offset is either that co-operation under certain circumstances serves survival better than aggression, or that there is an innate human need for co-operation which exists independently of, even in spite of, cultural indoctrination. If the former, Mr. Chase is merely stating a justification for writing the book, or making a plea for more rationality in human affairs. If the latter, the evidence of such innate needs is ambiguous. The third offset, that any culture is a network of co-operative habits, mostly unconscious, is a useful reminder that long-standing agreements are not only possible, but widespread, and that man has turned them out by the million.

The search for techniques of reaching agreement now begins in real earnest. Our first visit is to a Quaker meeting. For centuries the Quakers have been agreed on a set of procedures for settling problems. Although we are not told how agreement on these procedures was originally reached, we are given evidence of their usefulness for producing unanimous, realistic agreements on matters of policy and action. Chase points out that despite the Quakers' success, some of the procedures might not be readily agreed to by those Americans who lack the Quakers' philosophical and social traditions. Moreover, there are certain dilemmas in the Quaker solution; for example, the principle of delaying decisions until unanimity is achieved would lead to difficulties in situations where delay itself amounts to an action decision.

After examining a number of successful action groups which have adopted some principles similar to those that guide the Quaker meetings—including the board of directors of Standard Oil of New Jersey—Chase takes us to the laboratories of social psychologists who study the structure and dynamics of small groups. Two chapters are devoted to the program of the National Training Laboratory in Group Development held each summer at Bethel, Maine. "Bethel" has two functions: research in group dynamics and training in the theory and skills of group dynamics. The staff of the laboratory is drawn from various educational institutions, and the "delegates," who come to study and be studied, are drawn from industry, labor, education, social work, the armed forces, and various other fields. The method of training at Bethel would justify using the term laboratory even if no formal research were carried on.

The problems of group dynamics are studied as they arise in the group studying them. The delegates "do research on themselves," to learn how their behavior and the behavior of others affects the productivity, growth, and creativity of the groups in which they are associated at Bethel. Chase finds that the laboratory is making strides toward improvements in conference procedures, in classroom teaching, and in methods for bringing about better group productivity in solving problems and making decisions. His major concern over Bethel is the tendency of some delegates to regard it almost as a religious experience—an attitude which does not improve their participation in groups away from Bethel, and which is an ironic outcome of the staff's efforts to stress the earthly realities of working with groups.

One technique frequently used at Bethel particularly impressed the author, namely, the use of role playing for training in social skills, and for diagnosing difficulties of communication and other obstacles to successful group functioning. He cites many instances of its use in industrial training programs and other areas of human relations.

After a chapter summarizing the recommendations of the growing number of scientists and practitioners concerned with the structure and functioning of small groups, Chase concludes that "Group dynamics and group study are directing people's attention to the deepest source of human energy: interaction with their fellows." Enough progress has been made to conclude that the ineffectiveness of many committees and conferences is due to inadequate training rather than any "natural law," and the superiority of groups (given adequate training) over individuals as problem solvers has been demonstrated many times.

Three chapters are devoted to an area of American life notorious for conflict: union-management relations. The information Chase has gathered for these chapters indicates that this area deserves to be equally famous for the great progress which

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Roads to Agreement," by Stuart Chase. Harper & Brothers, New York, N. Y., 1951, 240 pp., $2.50.

has been made in developing techniques for reaching agreement. Chase cites the relevant facts of many cases where intense conflict has been replaced by peaceful harmonious relationships. The road to agreement has usually been a rough one. More than a desire for peace is necessary: There must be a willingness to work toward that end, and even more important, the work must be skillful. Until recently there has been no place but the "battleground" itself to learn the skills involved—experimentation and pioneering were the only methods. The arts of supervision, conciliation, collective bargaining—to mention a few—are now advancing rapidly. The recorded experience is there for anyone who wants to learn.

The most remarkable industrial experiments are represented by a growing number of companies in which the work force actively participates in the management of all aspects of the business. Under the guidance of Joseph Scanlon of M.I.T., a number of plants have developed a system of union-management participation, with unprecedented results in terms of productivity, economic well-being, and the high morale that goes with teamwork and increasing personal effectiveness of all concerned. Here management and labor are working together to establish a better industry and a better way of life in industrial society.

TVA is the subject of one of the most interesting chapters in the book. The Tennessee Valley Authority is well known as a great economic and technological experiment, but perhaps it is even more worthy of fame as a tremendously successful experiment in social collaboration. As the author points out, the administrative principles followed in TVA suggest a pattern of procedure which other administrations (public or private) faced with the problem of introducing large-scale technological change would do well to follow.

The trip to TVA winds up our round of visiting. After citing a few miscellaneous cases which bear on his subject, the author gives brief pointed lectures on two of his favorite recipes for improved human relations—semantics and cultural anthropology—and concludes with a discussion of the chances for survival of the United Nations and the world. He has found no magic formula for settling the continuing international crisis; he has also found that looking for a magic formula is a waste of time. This does not mean that the case is hopeless. It does mean that settling world differences will require hard work, creative imagination, and, above all, experimental-mindedness. His journey has netted some basic facts, basic skills, and basic points of view which will be necessary for the big job. Perhaps it can be done.

Chase usually writes enthusiastically, and his enthusiasm is usually contagious. Even when, as occasionally happens, the enthusiasm conceals logical defects, there is little harm done. His reporting is honest, his insights good, and his over-all message important. Many minor criticisms could be made of "Roads to Agreement." One has already been made in this review. But since such criticisms leave the main work intact, it seems pointless to devote more space to them.

Two comments in a somewhat critical vein may be made on the work as a whole, however. The first is the author's relative neglect of the question: Agreement for what? Probably he expects that his cases answer this question by implication, but the unwary reader might come away with the impression that agreement and peace are ends in themselves. Sometimes, in long-drawn-out union-management strife, for example, peace may indeed seem to be the goal. But even in international affairs, no one wants "peace at any price." The importance of agreement stems from the action which can be taken when agreement is reached. For the reviewer, this consideration differentiates the Scanlon union-management participation systems sharply from most of the other cases discussed in connection with industrial peace.

The second critical comment concerns the lack of an adequate conceptual scheme for selecting and organizing his data. It can be argued that Chase is a reporter and interpreter, rather than a theorist. However, there is some implicit theorizing, and in the reviewer's opinion, more of the needed explicit theory is available than Chase actually uses as a background for his discussion of techniques. The selection of elements to be considered in an analysis of the dynamics of agreement seems to have been determined by Chase's intuition (which is good) rather than derived from a set of explicit propositions. The lack of theory makes it difficult to fit the results of Chase's studies into the reader's general notions about how society works.

Another result is that the relevance of some cases and sections of the book to the announced topic is unclear. Agreement and contract have always been among man's most important conscious means for reducing uncertainty about the future. They provide the only basis for hope that we can be more than culture-bound automatons and victims of the unanticipated consequences of our own acts. The probable effectiveness of agreement and joint action is limited by such factors as psychology and physiology, and the state of science and technology. These considerations bring to mind a host of additional questions relevant to the dynamics of agreement. But perhaps we should ask that Chase write a separate book and be grateful that he limited himself to techniques and rules of thumb in this one. By and large, these shortcomings do not detract from the real virtues of the book. It's important and readable.

New Precision Barometer and Barograph

(Continued from page 974)

in this manner, the Micro-Barograph and Micro-Barometer may be expected to yield an accuracy in the determination of elevations of ±3 to 4 in.

Applications of Micro-Barometer and Micro-Barograph

In view of their increased accuracy, portability, and ease of operation, the Micro-Barometer and Micro-Barograph open up a number of new fields of application. In geophysical exploration their use will save considerable time in the determination of the elevation of seismograph shot points and seismograph receiver locations. They may be expected to speed up considerably the operation of gravimeters which are now handicapped by the need for accurate leveling of gravity meter stations. In civil engineering, geology, and geodesy, the accuracy of the new instrument will replace leveling operations in many instances.

The new instruments will also be of considerable help in military operations, particularly in unexplored country where accurate elevation values are not available for the artillery.

In meteorology, the Micro-Barograph may be used to advantage to record pressure fluctuations, particularly the horizontal gradients of these fluctuations. Above the ground, there may be possible uses in aircraft, particularly in more slowly moving types such as helicopters. Underground, the Micro-Barometer and Micro-Barograph have been used for the determination of pressure variations in mine workings in connection with underground ventilation problems.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Water-Supply Program

NOW, midway in the twentieth century, it has become suddenly clear that our water supplies are limited in relation to the many and varied needs for its use. These needs are growing in size and complexity as the population increases and as industry develops. More and more water is needed for our growing towns and cities, for bringing arid land into production, and for the tremendous demands of our new industrial techniques.

Water supply is a mighty industry. The water utilities in the United States now serve more than-100-million persons, delivering to them an average of more than 125 gal per person per day. In a single day our water utilities produce more than 13 billion gal, or considerably more than 50 million tons of safe drinking water. Their yearly water production is about seven times greater than the total annual tonnage output of all other industries put together.

To run this industry takes a corps of some 85,000 skilled waterworks men—men who know engineering, business management, bacteriology, conservation, and a host of other specialties. And the price? For less than 25 cents you can buy enough drinking water to last an average family an entire year. For a dime you can give your lawn a one-hour soaking. Water is the biggest bargain in our budget.

Much has been written about the growing lack of adequate water supplies. But the public at large still is substantially indifferent. Only when water supplies dwindle beyond safe limits, and a crisis develops, does the general public become aware of its precious asset and the danger of losing it.

How great is the job ahead—the job of providing necessary water-supply facilities? The accumulated estimate of new construction and modernization totals $12 billion. Much of this money must be spent soon in order to alleviate threatening shortages.

For without water, nations and civilizations are doomed. This is forcibly illustrated in the case of the Incas and the Pueblo Indians, two races believed to have disappeared more through the effects of drought than through any other cause.

Conversely, in ancient days Athens became a great city only after its water supply became adequate. The same is true, and to an even greater extent, in the case of ancient Rome.

In most instances where cities have been attacked and have fallen, the capitulation or defeat usually took place after the water supply had been cut off or destroyed. Modern-day examples of this may be readily found in the fall of Singapore, Hongkong, Madrid, and Berlin.

The drought conditions that existed in the New York City metropolitan area and in northeastern New Jersey during the latter part of 1949 and the first half of 1950 were foreseen far in advance by those charged with responsibility for developing water supplies for those areas.

FIG. 1 THIS SCENE, A STRIKING ILLUSTRATION THAT WATER IS THE LIQUID OF LIFE, SHOWS A SECTION OF DESERT THAT HAS BEEN TRANSFORMED BY IRRIGATION INTO FERTILE PRODUCTIVE LAND IN THE MIDST OF ARID WASTES

Had it not been for the interruption of World War II, new sources of supply for New York City could have been ready in time to have averted most or all of the effects of that drought.

In New Jersey a multiplicity of causes prevented following the advice of water engineers, who, as much as 20 years before, had foreseen the possibility and effects of such a drought.

In the southwestern part of the United States the life line of the entire area is the Colorado River. Without it, the entire area would suffer, and the city of Los Angeles—as well as much of the outlying territory—would be rationed in its use of water while populations gradually dwindled.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original mansucripts of these papers are available. Photostat copies may be purchased from the Library at the usual rates, 40 cents per page.

By comparison, the flow of the Colorado River is not much greater than that of the Delaware River, which New York City is planning to tap as soon as the Neversink and Downsville reservoirs and their accessories have been completed. Further efforts are being made to create another reservoir for New York on the west branch of the Delaware River at Canonsville. There is much opposition to such a procedure, and if allowed to prevail, this opposition can only result automatically in a situation parallel to that of 1949 and 1950.

Much has been said about the possibility of extracting potable water from the sea. At the present time it costs about three to five times as much to produce water by this method as by obtaining it from streams or wells. Unless some new and undiscovered process becomes available, this ratio of cost is apt to be maintained, and the use of sea water in large quantities does not seem at all feasible.

In most parts of this nation the water supply is relatively abundant, but it is not always available in the quantity and quality required at particular localities and at particular times. In a national emergency—with great shifts of population—new demands for water appear unexpectedly. The Congress on September 1 authorized the Public Health Service to provide financial assistance to communities in critical need to improve their water facilities for defense workers and military personnel.

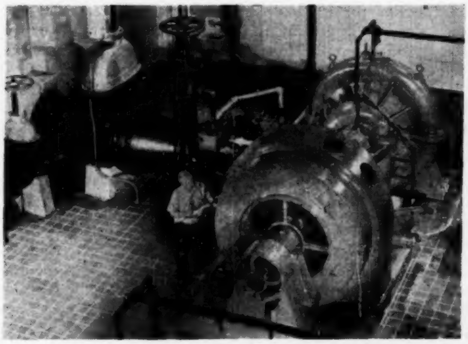


FIG. 2 VAST INSTALLATIONS AND SPECIALIZED MACHINERY SUCH AS THIS GIANT WATERWORKS PUMP AND MOTOR ARE NEEDED TODAY TO SUPPLY AMERICAN COMMUNITIES WITH THEIR GROWING WATER NEEDS

Another reason for local or temporary water shortages is that the normal increase in requirements has been prodigious. The demand for water is four times as great today as it was 50 years ago. It has increased from an average per-capita consumption of less than 50 gal per day in 1900 to a per-capita consumption approaching almost 200 gal per day in 1950.

Water shortages also arise from increased pollution. Our streams, lakes, and harbors are so polluted as to be unfit for industrial or domestic use unless the water has been expensively treated. The wastes include solids, organic substances, toxic chemicals, acids, alkaline materials, oil, and sewage. They color the water; they upset delicately balanced natural forces, and add tastes and odors which are often difficult to eliminate in water-treatment plants.

Industry uses more water than any other raw materials. Moreover, 44 per cent of our industries find it necessary to treat the water which they draw into their plants so that its quality will be satisfactory for manufacturing processes. If so much effort is required to provide water for industry's use, it is even more urgent that public-health officials be vigilant to protect and improve the quality of water that comes into the home.

The development of safe water supplies in rural and "urban fringe" areas is one of the major needs of public health today. The Public Health Service is working toward solution of this problem.

The construction needed to bring our water systems to a satisfactory level in communities or neighborhoods not now adequately served includes 3200 new water-treatment plants, 9000 wells and well pumps, 8200 water-storage tanks, and more than 45,000 miles of pipe.

To help fill this need and to inform the public that its sky-rocketing demands for pure water are seriously taxing the existing means of supply, the General Electric Company, Schenectady, N. Y., has recently launched a new Water Supply Program. Latest in the company's More Power to America series, the program features a 25-minute, full-color, sound motion picture, "Pipeline to the Clouds."

Dramatizing the importance of water to the individual and his community, the 16-mm film outlines the need for immediate action to combat potential shortages and to insure safe adequate supplies.

Other important elements of the program are a 40-page manual, "Good Water—and Plenty of It," and a four-page audience handout entitled "Wonders of Water."

The manual, prepared with the assistance of the American Water Works Association, is aimed at helping waterworks men, other municipal officials, and civic leaders in showing their communities the urgency of the water-supply situation.

The pamphlet, "Wonders of Water," presents startling and little known facts about water supply, and emphasizes the role of the individual citizen in water-works improvements.

Program kits, containing a print of the film, five copies of the manual, and 200 pamphlets are available at the reproduction cost of $170 to industrial and civic organizations wishing to conduct campaigns to improve local water-supply conditions.

The foregoing is based on addresses made in New York, N. Y., recently at the opening of GE's Water Supply Program

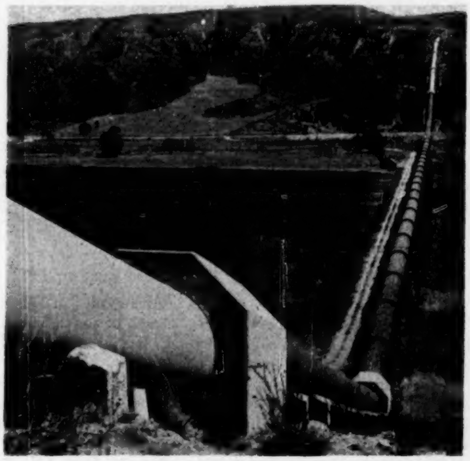


FIG. 3 PIPE LINES, SUCH AS THIS ONE, MUST REACH OUT EVER FARTHER TO TAP NEW SOURCES OF WATER

by H. R. Wallrath, manager, construction industries section, industrial divisions, General Electric Company; Charles H. Capen, Jr., vice-president, American Water Works Association, and chief engineer, North Jersey District Water Supply Commission; Dr. Leonard A. Sc...le, surgeon general, United States Public Health Service; and W. V. O'Brien, commercial vice-president, General Electric Company.

Lignite Laboratory

THE Charles R. Robertson Lignite Research Laboratory of the Bureau of Mines was officially dedicated at Grand Forks, N. D., on September 29, 1951.

A $750,000 building completed last December, the new laboratory was designed to solve problems arising from the development of large domestic reserves of recoverable lignite—estimated at 355,725,000,000 tons.

Under construction for a year and a half, the new laboratory contains a pilot plant for large-scale experimental work, and an administrative-laboratory wing with 27 well-equipped individual laboratories.

Designed to harmonize with buildings on the adjacent University of North Dakota campus, the laboratory has every modern facility needed for long-range research whose ultimate goal is greater use of lignite for power, heat, and other purposes. Lignite studies have been conducted by the Bureau of Mines in co-operation with the University for many years.

Research now in progress—preparation, chemical, drying, gasification, and other studies—may eventually mean greater industrialization and a new era of prosperity for the Great Plains and nearby states. It is under the direction of Alex. C. Burr, chief of the Region V Fuels Technology Division.

The Bureau of Mines gasification pilot plant, which began operations in 1945, and has completed its 18th test run, has produced to date a total of about 85 million cu ft of gas.

About 10,210,000 cu ft of potential industrial gas were produced from lignite during this run. The test run, longest to date, was voluntarily shut down after 947 hr of successful operation. The run used 438,415 lb of lignite donated by six mining companies located in North Dakota and Saskatchewan, Canada.

Known as water or blue gas, this gas could be used to heat homes or power plants, make synthetic liquid fuels, reduce Minnesota iron ore, manufacture ammonia for fertilizer for agricultural use, and for the hydrogenation of vegetable oils and fats.

Recent figures compiled by the U. S. Geological Survey place the nation's reserves of recoverable lignite at 355,725,000,000 tons. North Dakota contains nearly 300,000,000,000 tons, Montana nearly 44,000,000,000 tons, and Texas nearly 11,500,000,000 tons.

Diesel-Fuel Survey

ANALYTICAL data for 303 samples of four grades of Diesel fuel highlight a report of the second national annual Diesel-fuel survey conducted jointly by the Bureau of Mines and the American Petroleum Institute.

Recognizing the need for up-to-date information on the available kinds and qualities of Diesel fuels in view of the enormous increase in the use of Diesel power units, the first survey was undertaken last year. The 1951 survey, conducted in a similar manner, covers 37 more fuel samples than last year, and includes a number of designations of some samples for recommended use only in winter or summer. It also establishes new national marketing districts, based on supply systems, refinery locations, traffic arteries, etc., instead of employing the 1950 districts which were based on motor-gasoline surveys. The samples represented the products of 49 manufacturers, seven fewer than the number of refiners contributing data in 1950.

Samples of Diesel fuel typical of actual shipments were taken during 1951 and analyzed according to accepted uniform procedures by the manufacturers of the fuels. Fourteen tests were applied to the samples, and the results were forwarded to the Bureau of Mines for study and compilation. Of the 303 samples tested, 139 are Diesel fuel for city buses and similar equipment, 112 are for heavy trucks, tractors, etc., 27 for railroad Diesel engines, and 25 for large stationary plants and marine Diesel engines.

The report presents the tabulated data in four grade groups in accordance with specified limitations set forth by the American Society for Testing Materials as follows: (1-D) Diesel fuels of 625 F maximum end point; (2-D, first section) Diesel fuels of 675 F maximum 90 per cent point, with pour points 0 F and below; (2-D, second section) Diesel fuels of same 90 per cent point with pour points above 0 F; and (4-D) Diesel fuels not conforming to the foregoing limitations.

A comparison with the 1950 survey shows that there has been little change in the quality of Diesel fuels during the past year as an examination of average, minimum, and maximum values of the fuels covered in the 1951 survey fails to reveal any great differences from the 266 samples described in the report of last year's survey. In general, the data indicate that high-quality fuels are being supplied to meet the special requirements of the various grades.

A free copy of Report of Investigations 4830, "National Annual Diesel-Fuel Survey, 1951," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Improved Diesel Fuel

THE U. S. Navy is testing a new chemical compound designed to raise the quality of Diesel fuel to Navy requirements without the refining now necessary, Rear Admiral H. N. Wallin, Chief of the Navy's Bureau of Ships, announced recently.

If successful, the compound will greatly increase the amount of fuel oil available for submarines and other Diesel vessels without added strain on the nation's oil refineries.

The compound is the result of four years of research by the Ethyl Corporation. It is a blend of several amyl nitrates found to be the most economical and practical as a quality booster of Diesel fuel.

Small amounts of the blend added to Diesel fuel will improve its quality, causing it to ignite more readily in the combustion chamber of an engine.

Diesel-fuel quality is now raised to Navy specifications by refining which reduces the amount of usable fuel that can be obtained from a given quantity of crude oil. With use of the new blend, much of this refining might be eliminated which would permit refiners to meet enlarged wartime demands. It would also permit them to devote more of their facilities to production of other critically needed fuels.

Even without increased defense demands, the compound is expected to ease the job of oil refiners in meeting the normal rise in demand for Diesel fuel. This demand has jumped fourfold in the last ten years.

Also foreseen is the possibility that Diesel manufacturers will be able to design engines to operate on a uniform grade of fuel from coast to coast, instead of on the broad range of fuels now

being produced, and thus insure better engine performance. This may be possible because the new compound, when added in different amounts to fuels of different grades, could raise them all to a uniform level.

No plans for making the amyl-nitrate blend commercially available have been announced by Ethyl Corporation. Such plans are not expected until after the Navy tests are concluded. The company is now producing only those quantities required for test purposes.

Coal-to-Oil Processes

MORE than 3500 domestic and foreign patents dealing with pressure hydrogenation—a process for the conversion of coal to oil—are listed in a bulletin compiled by the Bureau of Mines and now available through the Government Printing Office. The bulletin is Part II of a three-part report on pressure hydrogenation.

With condensed listings and descriptions of the patent applications, the 287-page bulletin lists patents in alphabetical order, together with filing dates and reference data. Included in the patent listings are developments of Russian, German, Japanese, French, Italian, and British origin.

Published in October, 1950, Part I of this series listed and abstracted all available literature and pertinent data on synthetic-liquid-fuels research. The final Part III will list patents numerically by countries and will have a detailed index of all material contained in Parts I and II.

For several years the Bureau of Mines has carried on a broad program of research in producing synthetic-liquid fuels from coal, oil shale, and other materials. The Bureau is now operating a coal-to-oil demonstration plant at Louisiana, Mo., and an oil-shale mine and demonstration plant at Rifle, Colo.

Copies of Bureau of Mines Bulletin 485, "Bibliography of Pressure Hydrogenation, Part II, Patents," can be obtained only from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for $1 each.

Heat-Pump Installations

HIGH coefficients of performance were reported for the heat-pump installation, one of the largest in the world, which operates the complete air-conditioning system in the Oregonian Building, housing the newspaper plant and offices of the Portland "Oregonian." The report was made at the semi-annual meeting of The American Society of Heating and Ventilating Engineers in Portland, Ore., by J. Donald Kroeker, consulting engineers; John H. Bonebrake, of Mr. Kroeker's office; and James A. Melvin, chief operating engineer of the Oregonian Building.

The engineers described the operation of the installation for the bulk of the 1949 heating season with the system operating under complete automatic control. They said the net coefficient of performance, figured conservatively, was 10.2 at an outdoor temperature of 30 F, and 20.8 at the average outdoor temperature of 49 F. The coefficient of performance is computed as the ratio of the total heat used in heating the building and in heating the air going into it as related to the total electric energy used by the system in producing that heat.

Three wells drilled in downtown Portland to depths of 235, 204, and 930 ft are used as heat sources for the heat-pump installation. The Oregonian Building extends five stories above and two below ground level, and completely occupies a city block, 200 × 200 ft. The building has a floor area of 220,000 sq ft and a volume of 4,270,000 cu ft.

While the Portland climate is relatively mild and air conditioning of office buildings is not general practice, it was necessary to use complete air conditioning in this building because ventilating courts had been eliminated to facilitate uninterrupted flow of material in the mechanical processes of publication.

In addition, as the structure is designed for heavy loads, deep steel beams had to be used and these prevented adoption of an all-air heating and air-conditioning system.

Among the innovations described by the engineers were the use of well water for preheating and precooling, the recovery of heat from exhaust air, and a completely automatic control system, even to the point of starting and stopping the centrifugal refrigeration equipment.

Numerous conclusions which apply to commercial heat-pump installations were drawn from design and experience by the engineers, as of possible use to others in planning large installations. They are as follows:

1 The economy in recovering heat from waste products and the preconditioning of ventilation air with cold water should be investigated.

2 A commercial heat-pump installation can be only as good as the automatic temperature and sequence control provided. Consideration of only industrial types of controls which can obtain greater accuracy and flexibility than usual air conditioning and heating controls is recommended for use in basic master-control sequences.

3 Abnormally detailed studies of loads and methods will pay dividends in economy of operation.

4 Determination of economic feasibility requires a rather thorough study of application methods. Comparison of only power rates, arbitrarily chosen coefficients of performance, and costs of alternate energy available, will be misleading and inconclusive.

5 Well-water development should precede design, since, in many localities, information based on performance of wells in the vicinity may not apply fully.

6 Sand traps in well-water supplies, such as settling tanks, are justified, even for wells apparently entirely free of sand.

7 Water analyses should be carefully studied for possible chemical treatment required to protect system metals. The employment of consultants is advised. Some advice of purveyors of proprietary compounds has been found to be misleading and flavored with prejudice.

8 Shafts of pumps handling well water which show even traces of sand should be made of hardened metals, such as stainless steel, or of the molybdenum group of alloy steels.

9 Generally, a heat-pump installation having a capacity of more than 150 tons will require, even though it is fully automatic, at least the part-time attention of an operating engineer, who may also have other duties. Such a person should be personally selected or subject to approval by the designing engineer.

SOUTHERN HEAT PUMP

The two-year performance of a heat-pump system furnishing year-round air conditioning in the new six-story office building of the Appalachian Electric Power Company, at Roanoke, Va., was described at the same meeting by E. R. Ambrose, Jun. ASME, air-conditioning engineer of the American Gas and Electric Service Corporation of New York, from a report prepared by Mr. Ambrose and Philip Sporn, Fellow ASME, president of the corporation. Mr. Ambrose said the system, a 225-hp installation using outdoor air as the heat source and heat sink, operates at a coefficient of performance of from 4.28 to 2.85, depending on the speed and the number of compressors operating.

The Appalachian Electric Power building encloses a volume of 1.15 million cu ft excluding the garage; is 152 ft long × 96 ft wide × 60 ft high and provides 87,600 sq ft of floor area. The outdoor-air coils are located in the penthouse above the sixth floor and the outdoor-air fans are located directly above on the penthouse roof.

The fans discharge the outdoor air vertically downward through the coils, then back to the outside. Basement storage tankt charged with warm or cold water, depending on the season, provide practical compressor selections having flexible and efficient operation. All of the other heat-pump equipment is located in the penthouse above the sixth floor.

Individual room control is obtained by 153 unit room air conditioners located throughout the building, and supplemented by a direct system for ventilation air. The system consists of three heat-pump units of 75 hp each.

In addition to the heat pump for year-round comfort air conditioning, a small heat pump supplies the domestic hot-water requirements for the entire building. The air exhausted from the building is used as the heat source. This heat pump was designed to heat 50 gal of water per hr from 50 to 120 F. The heated water is stored in a 300-gal insulated tank. Exhaust air from the building goes over the compressor and through the cooling coil to the exhaust fan, where it is discharged to the outdoors. The heat removed from the exhaust air by the cooling coil is raised to a higher temperature and transferred, together with the heat equivalent of the work of compression, to the water by means of a refrigerant-water heat exchanger.

The 153 conditioner units and the forced-air-distribution system which conditions the internal area and supplies all of the ventilation air requirements, maintain comfortable conditions throughout the building during both the heating and cooling cycle.

Mr. Ambrose said the heat-pump equipment has required relatively little maintenance and service during the two-year period of operation, adding that the actual energy consumption during the heating cycle indicates that the operating cost of a heat-pump system, using air as a heat source is competitive with other fuels in the Roanoke area.

The heat pump possesses many unique and desirable features which are adaptable to practically any type and design of year-round air-conditioning system, he declared. The heat pump can provide instantaneous, automatic, and simultaneous heating and cooling with the same equipment. A chimney is not required for the unit because no flame of any kind is used and, consequently, there are no products of combustion, soot, dirt, or odors.

NEED FOR DATA

The introduction of the heat pump in the field of space heating has created a demand for information not generally available, George S. Smith, professor of electrical engineering at the University of Washington, Seattle, Wash., declared at the meeting. Since the major portion of the heat supplied by a heat pump is drawn either from the air or the outer layer of the earth's crust, he said, the design of this type of heating plant must depend upon temperatures and temperature changes at various seasons of the year.

Professor Smith presented a considerable quantity of such data collected in the Pacific Northwest area by the University of Washington Climatology Recording Station and two other sites over a period of two years. Professor Smith related his data to corresponding U. S. Weather Bureau records, which are quite generally available, in such a way that such weather statistics for any locality might be used to determine much of the necessary information. Eventually, he said, the accumulation of information from various parts of the country will permit interpolation of design data sufficiently accurate for most design problems.

The amount of heat available for a heat-pump ground grid, Professor Smith said, is probably limited to the heat adsorbed by the soil from the sun's radiation, plus that precipitated from the atmosphere and carried in by the rain. The solar heat thus supplied to the earth per square foot of surface may be closely approximated by calculation.

Professor Smith described his methods of using Weather Bureau records as "approximate."

To determine more accurately the ground heat available, the temperatures near the surface of the soil must be obtained throughout the year, and even these would give information for that year only, he said. Needless to say, the time and cost would, in general, be prohibitive. If similar comparisons could be made between the approximate methods and the more accurate ones wherever actual ground surface temperatures are available, the accumulated results would probably suggest a very acceptable procedure until enough experience with heat-pump and ground-grid operation has been acquired to suggest better methods, he concluded.

Turbogenerator Cooling

A NEW method of cooling large turbine generators that will make it possible to increase ratings by as much as one half has been developed by the Westinghouse Electric Corporation, Pittsburgh, Pa. The new cooling technique consists simply of blowing hydrogen gas at high velocity through specially constructed hollow generator coils. This brings the hydrogen, the cooling medium, in direct contact with the copper in which the heat is generated.

Since this cooling method reduces to almost zero the heat flow through the coil insulation, the temperature of the copper coils is determined by the temperature of the hydrogen gas, and the heat-transfer coefficient from the copper to the hydrogen. Therefore, for a given maximum temperature rise, it will be possible to pass more current through the coils, since the additional heat that results can be quickly dissipated.

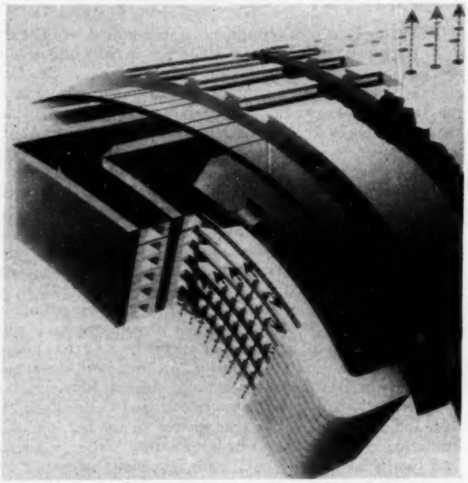


FIG. 4 CUTAWAY VIEW OF A ROTOR AND ROTOR WINDING

Internal cooling is particularly applicable to units for ratings of 90,000 kw and above. The improved cooling is said to make possible the construction of ratings much larger than now possible with conventional hydrogen cooling. Ratings of 3600-rpm single-unit generators of 250,000 to 275,000 kw now appear possible at power factors and stability characteristics suitable for the large electric-utility systems.

The increase in copper losses due to higher current densities is more than offset by the reduction in bearing losses resulting from the smaller bearings required for the smaller rotors, and the reduction in rotor surface losses resulting from the appreciable increase in the radial length of the air gap and the decrease in rotor surface area.

Under present conditions, the reduction in physical size of generating units for a given rating is of paramount importance since it results in the conservation of our nation's two most necessary critical materials—copper and steel. Higher costs per unit weight offset any possible cost savings resulting from the use of smaller amounts of copper and steel. Large-capacity turbine-generator units of this type, even at present costs, however, should result in lower over-all station capital and operating costs without any sacrifice in efficiency performance.

Fig. 4 shows the path of the hydrogen gas flowing through the rotor conductors for a particular type of construction.

At present, the development of the inner-cooled stator coil has not been carried to the same stage as for the rotor, and it therefore may be advisable to apply internal cooling in two steps—the first for the rotor alone, and the second for the stator.

The development of internal cooling with high-pressure hydrogen gas opens up a new era in the design and construction of turbine generators without too great a departure from present practice and experience, Westinghouse engineers stated. Two generators with internally cooled rotors and rated 175,000 and 200,000 kw are to be completed in 1954, and a 90,000-kw 3600-rpm unit with both rotor and stator internally cooled is now being designed and is expected to be available for testing late in 1952.

New Metalworking Machine

A NEW method of metal removal which employs the direct utilization of electric energy for the machining of any electrically conductive material has been developed and made available to the metalworking industry by the Method X Corporation of Philadelphia, Pa., an affiliate of the Firth Sterling Steel and Carbide Corporation, Pittsburgh, Pa. The Method X machine, as it is called, removes metal by means of an electric spark discharge which does not otherwise affect the work material's physical or chemical characteristics.

The machining action depends on a mechanical, not thermal, effect of electricity which sets up internal mechanical stresses by the use of extremely high current densities, thereby causing the metal particles to detach themselves from the work material without resort to melting. The exposed surfaces thus remain unchanged and surface finishes of 26 microinches rms can be obtained. Lapping of less than 0.001 in. will produce any desired finish down to 0.15 microinch on sintered carbide. Center-to-center spacing of holes through the same workpiece can be controlled to approximately 0.0005 in. Blind-hole fillet radii can be made as small as 0.002 in.

Reports indicate that not only can the new process be used to machine the conventional shapes but it is capable of machining such hard-to-machine metals as sintered carbides, super-alloys, S-816, vitalium, and hardened steels into complicated geometric shapes economically and rapidly.

The shape is formed by the use of an electrode made to the shape desired and fed directly into the workpiece by the Method X machine. A second finishing operation is performed with the use of the same electrode by cutting off the eroded end of the electrode and making necessary electrical adjustments and re-entering the electrode in the rough-shaped hole.

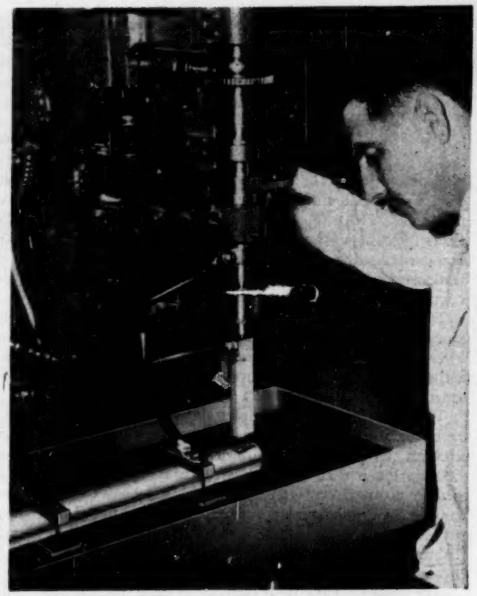


Fig. 5 Method X Machine for Performing Machining Operations

(An electrode, negative of the shape to be produced, is fed directly into the material. The loosened particles are carried away from the work area by a dielectric fluid.)

The machine's design is similar to a drill press with a pedestal-type base, an electrode feed and control mechanism, and a remote-unit power supply. The machine has a worktable provided for longitudinal, lateral, and vertical traverse, and full rotation for work alignment. Electrode feed is automatically controlled by an amplidyne and associated circuits so that optimum cutting speeds for a given cutting condition are maintained. The power supply is fed from 220-volt 60-cycle single-phase lines.

A dielectric fluid such as fuel oil, kerosene, or a compound especially developed for this purpose, Dielectro X, is used to enclose the cutting operation. The purpose of the work submersion in the Dielectro fluid is first, to build up electrical resistance so that the energy storage devices in the machine may be fully charged prior to discharge, and second, to flush the loosened particles from the work area. No fluid is lost except through evaporation or carry-off on the fabricated parts.

Electrodes are made of a highly conductive, easily machined material, such as brass, although other conducting materials may be used. They are usually machined to a negative of the shape to be produced when the machining operation can be performed with the head moving in a vertical direction. When the machine is required to revolve, or the worktable traverse, for an internal irregular contour, an electrode of brass wire bent to the necessary working angle is all that is required since the tool does not make physical contact with the work.

Savings Through Standards

A REPORT of a survey to obtain data on savings derived from the use of standards by American industry appears in the October, 1951, issue of *Standardization*. Entitled, "Dollar Savings Through Standards," the report attempts to compile a body of measurable proof in terms of dollars or percentages of net savings and specific economic benefits attributable to standardization. The first survey of its kind, it represents 140 documented case studies, covering 81 industries and industrial products. Most of this information was supplied to the Economic Cooperation Administration through the American Standards Association, which got it in a special survey of its 110 trade association and technical-society members, and 2000-odd company members.

The report reveals a sharp rise of the standards movement since the war, particularly in the past two years. Company after company refers to recently installed standards programs. Others speak of programs not yet completed or about to be started.

The most obvious generalization that can be drawn from the results of the survey is that standardization is truly an essential element of the American industrial system. Another important observation is that standardization programs in all degrees of development are currently to be found. The cases show various stages, ranging from elaborate and well-established procedures to initial or tentative efforts. The larger the industrial establishment the more important it is that the fullest possible use be made of standards at every stage of the productive process.

The "cases" have been roughly divided into groups under such headings as "mechanical manufacturing," "machine tools," etc., some of which are necessarily duplicated in Section IV, Supplementary Cases. However, it is obvious that many industries which differ a great deal in the nature of their products still utilize identical standards for items like industrial fasteners, screw threads, etc.

Attention is particularly directed to the full indexes which are found at the beginning of the report. The first index is a list of the reporting industries, arranged alphabetically, showing the corresponding case numbers. The second index is a list of the various subjects of standardization discussed in the cases, arranged alphabetically by subject, and showing the corresponding case numbers. The specific interest of the user of the report will determine which index is applicable.

Individual copies of this document at $1 each can be obtained from the American Standards Association, Incorporated, 70 East 45th St., New York 17, N.Y. ECA is distributing the report abroad; in this country, copies can be obtained only through ASA.

Wind-Tunnel Drive

A 250,000-HP wind-tunnel drive, capable of creating supersonic blasts of air, is being constructed in Schenectady, N. Y., by the General Electric Company, as part of an order placed with G.E. by the National Advisory Committee for Aeronautics. The giant drive will be installed in a new wind tunnel being built at the Lewis Flight Propulsion Laboratory in Cleveland, Ohio.

The new tunnel will be used to test aircraft power plants in the ramjet, gas-turbine, and rocket categories.

While rated officially at 250,000 hp, the drive will have a peak one-hour output of 300,000 hp, according to G-E engineers. The drive will consist of four 37,500-hp and three 33,334-hp variable-speed a-c induction motors linked with two axial-flow compressors.

Four of the motors will be mounted in tandem on a single shaft operating one compressor, while the remaining three will operate on the second compressor. Peak wind velocities will be obtained by operating the compressors in tandem.

The individual motors, among the largest of their kind ever built, will each weigh about 120 tons and will be approximately 14 ft high, 14 ft wide, and 25 ft long.

Complete controls and switchgear will be supplied by G.E. Included in this equipment will be one of the largest orders ever placed for static capacitors for power-factor correction.

General Electric also is constructing a 180,000-hp wind-tunnel drive for NACA's Ames Aeronautical Laboratory at Moffett Field, Calif.

TV in Power Stations

THE application of television for direct viewing of furnace conditions has been in the process of development for some time at the Port Jefferson Power Station of the Long Island Lighting Company, according to an article by L. M. Exley, Mem. ASME, of the Long Island Lighting Company, in the July, 1951, issue of *Combustion*.

At present, such an installation provides the operators in the centralized control room much needed information about conditions existing in the furnace of one steam-generating unit firing pulverized coal.

Development of the use of this television equipment has been carried to its present status through the combined efforts of the Diamond Power Specialty Corporation of Lancaster, Ohio, and the staff of the Port Jefferson Power Station.

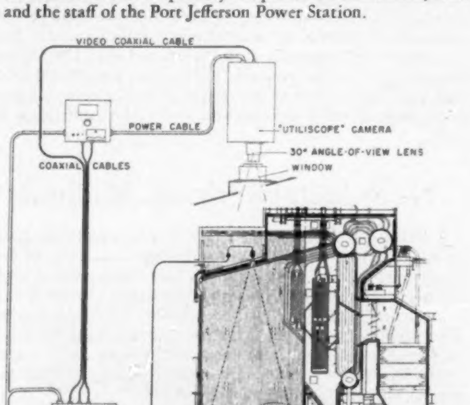


FIG. 6 SKETCH SHOWING TELEVISION CAMERA LOCATION

FIG. 7 ALL FOUR LIGHT-OIL BURNERS ARE SHOWN IGNITED

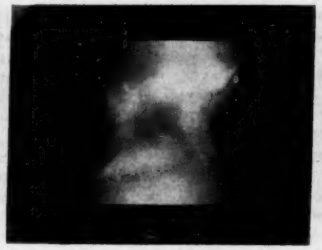


FIG. 8 APPEARANCE OF FIRE SHORTLY AFTER PULVERIZED-COAL IGNITION

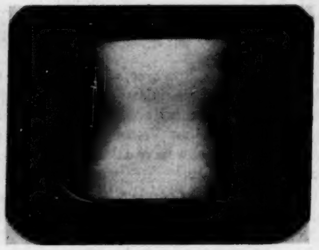


FIG. 9 APPEARANCE OF FLAME AFTER CONDITIONS BECOME STABILIZED

As shown in Fig. 6, the camera unit is mounted over a centrally located opening in the roof of the water-cooled furnace of a 425,000-lb per hr, tangentially fired, steam-generating unit. In order to provide an opening of sufficient size two bent sections of roof tubes were installed at this point. The camera lens is protected from heat by a water-cooled window. The camera unit will withstand temperatures of 150 F or over, so requires no cooling. From this camera location the picture is transmitted to the viewer, which is located on the steam-generator panel in the centralized control room.

Operating experience with the installation has been as follows:

1 Preparatory to lighting off, the ignition torches are shown satisfactorily on the screen in the control room and the man who operates the control for ignition of these torches can observe their operation.

2 In lighting off coal from either the light-oil burners or from the ignition torches the screen becomes black when pulverized coal is first admitted to the furnace. Ignition normally takes place in about 30 sec. As soon as this takes place the flame pattern appears on the screen. The stability of the flame and the point at which ignition is taking place, with respect to the burner nozzles, is indicated clearly.

3 Television shows many burner conditions that could not be analyzed by other means on either oil or coal, at any rating. For example, before television was installed, during burner cleaning periods on oil firing, dark puffs were usually observed from the stack. The logical conclusion was that the operators were cutting the oil burners back in service too quickly. Television showed that the dark stack was caused by purging the oil burners too rapidly.

High-volatile coal from the Fairmont, W. Va., district is now being burned at Port Jefferson. The volatile matter of this coal is in the range of 36 to 39 per cent which increases the possibility of burner coking. The television equipment has been very helpful in burning this fuel, as it provides a better picture at the point of ignition than can be determined by observing the furnace through the various peepholes. Visual inspections of the burners for coking are still made periodically but coking has been almost entirely eliminated by keeping ignition further from the burners than would be considered practical without the use of television.

Any burner condition which affects combustion, such as unequal fuel distribution, is very noticeable on the screen. Other things, such as cleaning ash from the dry-bottom hopper or blowing of the waterwall soot blowers can be seen also.

Incomplete combustion in the furnace is readily detected in the picture on the screen, and therefore aids in maintaining a clear stack. This is of extreme importance not only in locations where rigid smoke-control ordinances are enforced, but also because of the country-wide attention being given to smoke abatement.

4 Loss of ignition due to stoppage of oil or coal flow is shown instantaneously by a black screen. The operator can verify the loss of ignition under this particular condition by observing the furnace draft gage, which always changes at loss of ignition, and pulverizer instruments in the case of coal, or fuel pressure gage in the case of oil.

5 It is believed that the television installation at Port Jefferson will assist in detecting, but not definitely show, any condition which might result in a furnace explosion. Any large reduction of air flow, without reduction of coal flow, results in a rich, explosive mixture in the furnace. Under such conditions ignition is seldom lost. Such conditions may be brought about by failure of automatic controls, failure of a forced or induced-draft-fan motor, or failure of dampers in forced or induced-draft ducts. In such cases the television screen becomes black, even though ignition is maintained. As the television camera is at the top of the furnace, unburned fuel rises and obscures the burners under such conditions. Further studies are being made at this time in order to analyze the information available on the television screen so that it can be used to assist the operators to greatest advantage.

Thus far, television is highly endorsed by the control-room operators as an important operating aid. In fact, they express uneasiness when it is removed from service for any reason. It holds promise of widespread application, especially among central-station boiler plants.

British Aircraft Display

REPRESENTATIVES from more than 90 countries were given an indication of the speed of things to come when they watched Britain's latest aircraft fly past during the recent air display at Farnborough, in Southern England, organized by the Society of British Aircraft Constructors.

According to a commentary on the show by Charles Gardner, received from British Information Services, discounting experimental and research aircraft, greatest interest centered around four or five machines which are already in quantity production—the de Havilland Comet four-engined jet airliner, soon to go into service with British Overseas Airways Corporation; the Vickers Viscount turboprop airliner, ordered for British European Airways; the Vickers Valiant world's first four-engined jet bomber; the Hawker 1067 sweptwing fighter, and the Vickers 508 naval fighter.

Both the Comet and the Viscount airliners represent such an advance on their piston-engined competitors that they can genuinely be said to start a new form of travel, Mr. Gardner

said. The Comet, for example, with its 500-mph cruising speed, will nearly halve the journey time on all the routes on which it will operate.

The Viscount, however, will rely not so much on speed as on her smooth, vibrationless, and silent flight. Both aircraft are attractive economically. It is reported that airlines in Europe are inquiring about Viscounts, and that some of the leading airlines of America have asked for Comets, subject to delivery-date satisfaction.

The Valiant jet bomber has a sweptwing and swept tail of exceptional cleanliness. Its power comes from four Rolls Royce Avon jets, which are so unobtrusively installed in the wings that all you can see of them is the wing-root grilles over the intakes.

The new Hawker 1067 fighter has been claimed by Britain's Secretary of State for Air as the "fastest in the world." There are only two planes which the 1067 has to beat—the F86 Sabre and the Mig 15. With its latest Avon, the Hawker is much more powerful than either (it has, of course, the advantage of being a newer machine). Furthermore, its rate of climb and rate of roll are both exceptional. The Sabre, of course, holds the world's speed record at 670 mph.

The most powerful naval fighter, according to Mr. Gardner, is the Vickers 508, which has two Avons mounted side by side in the fuselage. No other fighter, he claims, has anything like the power of two Avons.

As for engines—the Avon and the Armstrong Sapphire will play a big part in Western rearmament, and the Sapphire is already being built in America to play a part in the rearmament over there, Mr. Gardner said. The official thrust figures are, for the Avon 6500 lb and for the Sapphire 7200 lb. Both are in widespread production. Particular interest was shown in the Napier Nomade, a combination of Diesel and gas-turbine engines.

Finally, Britain at this moment holds two major world records—that of absolute height for an airplane, and of rate of climb to 12,000 meters (39,370 ft). Mr. Gardner believes she should be able to add to that the absolute speed-record—barring rocket experimental machines.

Altogether there were 51 aircraft on show at Farnborough compared with 34 at the Society's first display in 1932. And of the 51 this year, no less than 28 were jet propelled. The average speed of all the machines—including the tiny slow-flying Austers—was 400 mph.

The fastest thing at Farnborough, according to Mr. Gardner, was a bifuel research rocket capable of speeds up to 2000 mph. It was shown on the stand of Britain's Ministry of Supply in the static exhibition.

Air-Borne Radar Device

LATER versions of the British Overseas Airways Corporation's Comet jet airliners are to have a radar device in the nose which will give the pilot a warning picture of approaching storm clouds. Known as the Air-Borne Search Device, the radar set "screens" any solid objects in the path of the aircraft up to a distance of 40 miles—the approach of a hard core of a cumulo-nimbus cloud, a mountain top, or another aircraft.

The searcher has a high-frequency beam which covers a sector of space ahead of the aircraft. It scans through an angle of 75 deg each sec, and if the beam hits a "solid" object, signals are reflected back on to the radar screen.

Any storm-filled cloud or other object with a "hard" center in the wedge-shaped sector of space covered by the beam will automatically be screened. Distances are marked off on the screen and the pilot can determine the range of objects ahead to within a few hundred yards.

The radar pictures show hidden gaps through giant cloud banks which are quite hidden to the eye and enable the pilot to select a storm-free path which avoids dangerous turbulence, and make a trouble-free climb or descent through the storm clouds.

En route the Comets will normally cruise high above the weather, 40,000–50,000 ft up, and during that time the beam of the searcher will be lowered so that it sweeps the ground instead of the sky dead ahead. When tilted downward, the radar screen is used as an automatic map reader: it shows coastlines, rivers, lakes, and ships. A ship can be picked up on the screen 25 miles away, and a small dinghy five to six miles off.

Tests on the equipment have been made by the Telecommunications Research Establishment, by a Royal Air Force Transport Command Development Unit, and by BOAC's Operational Development Unit. Early tests took place over Singapore, said to be one of the most thundery regions in the world, where clouds towering from 15,000 to 41,000 ft up were identified accurately.

The complete installation weighs about 175 lb and is built by Ekco (E. K. Cole Ltd.).

175-Hp Gas Turbine

ACCORDING to a recent issue of the *Aluminum Bulletin*, the U. S. Navy is now testing a 24-ft boat fitted with a 175-hp gas turbine at the U. S. Naval Engineering Experiment Station, Annapolis, Md. A boat of this type could be used for seaplane operations. Its high speed would permit efficient and speedy rescue in cases of plane crash.

The engine consists of a single-stage centrifugal compressor with two outlets, two constant-pressure burners, and a compressor-driving turbine having a rated speed of 36,000 rpm. The power-output stage consists of another turbine with a rated speed of 24,000 rpm and 9.6 to 1 reduction gear. To keep weight to a minimum, aluminum is used for a number of major components.

Weighing only 150 lb, the engine is light enough for two men to lift and occupies less space than a household washing machine. Maintenance is simple, as there are about one tenth as many parts as in a conventional gasoline or oil engine of comparable horsepower. Output will vary between 100 and 200 bhp, depending on the endurance life expected. The turbine can drive the boat at speeds up to about 21.7 knots with much less vibration than a Diesel or gasoline engine of comparable power.

Smooth starting is an outstanding characteristic of the gas turbine. The engine in the experimental boat will start and attain full speed in about seven seconds. It runs equally well on gasoline, kerosene, and light or heavy fuel oil. It is considerably quieter in operation than a conventional piston-type engine.

The turbine is still in the development stage and is not yet ready for production. Although emphasis has been placed on reliability, other phases of the turbine's proving have not been neglected. Design changes already made to improve operation of the unit are: A more rigid but lighter-weight cast frame, replacing the original fabricated frame; a new accessory drive unit; cast-aluminum burner elbows, replacing the steel-fabricated ones formerly used; development of a new-type ignition plug, and addition of a crossover tube between burners to insure quick, dependable two-burner starts; and circular exhaust outlets which permit the small-volume turbine to be installed in an even smaller space than previously.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Industrial Instruments

Effect of Eccentricity on Instrument-Gear Accuracy, by Richard L. Thoën, General Mills, Inc., Minneapolis, Minn. 1951 ASME Fall Meeting paper No. 51—F-36 (mimeographed).

IN the design of mechanical instruments, the problem often arises wherein a shaft must be positioned within a specified angular tolerance. Often as not the design may carry a limiting space dimension. Normally, a survey of the various methods available for angular positioning would be conducted and, since every angular-positioning device contains certain inherent inaccuracies, it becomes necessary to understand how these inaccuracies affect the angular position of a shaft. For example, in the case of spur gearing, the gear parameters should bear a certain safe proportion to the gear imperfections; otherwise, the effect of the latter would cause the angular tolerance to be exceeded. This paper describes one of the effects that produces errors in one type of angular positioning, namely, eccentricity in spur gears.

Basic formulas are derived which, when applied to a train of eccentric gears, enable the designer to predict the angular error and backlash at the output shaft.

A Method for Controlling Moisture Content of Foundry Sand, by A. M. Severson, Jun. ASME, and J. J. Uppgren, University of Minnesota, Minneapolis, Minn. 1951 ASME Fall Meeting paper No. 51—F-37 (mimeographed).

A METHOD for controlling water addition to simplify and increase the accuracy of moisture content in foundry sand is described.

A control system of the mercury-manometer type, used together with a bubbler system, was found to be particularly adaptable to the application. The design of the instrument is such that the unit could be made almost completely automatic by mechanically connecting a temperature-responsive element to the presently fixed electrode and in this manner automatically reset the unit for varying sand temperature.

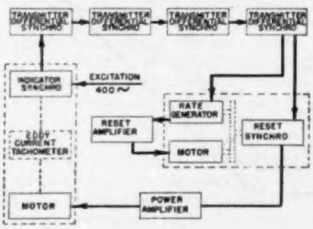
The simplicity of the instrument lends itself to ease of manufacture and ease of equipment.

The instrument could be adapted for other batch-type processes. It could also be used to measure liquid levels in units such as tank farms. Small pressure tubing leading to each tank bubbler system could be connected to such an instrument in a control station. By a proper system of valves, the liquid level of any tank could be easily determined.

A Multiple-Input Totalizing System, by James E. Bevins and George S. Miles, Bendix Aviation Corporation, Teterboro, N. J. 1951 ASME Industrial Instruments and Regulators Division and Instrument Society of America, Joint Conference paper No. 51—IIRD-2 (mimeographed).

DESIGNED originally for multiengine jet aircraft, this system totalizes the rate of flow and quantity of fuel consumed. It combines a variable orifice flowmeter with differential synchros and a novel servo system. Each of these components is fully described and the versatility of the system is demonstrated for use in other control and indicating systems where isochronous speed control is necessary.

The multiengined totalizing system is made up of three components—the transmitters, amplifier, and indicator. From two to four transmitters are used in this system and have a range of from 500 to 10,000 lb per hr and will operate up to 800 psi working pressure. The amplifier is operated from 115-volt 400-cycle power and requires about 40 volt-amp. The indicator has a two-concentric-pointer-type presentation and operates



MULTIPLE-INPUT TOTALIZING SYSTEM BLOCK DIAGRAM

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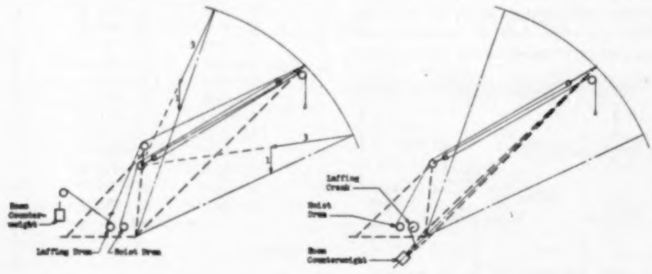
from 0 to 40,000 lb per hr with four revolutions of the fast hand and has a smallest increment of 100 lb per hr.

The multiple-input totalizing system can be used for indicating the results of any processes where a flow of a product is involved. This flow need not be liquid but could be the output from several conveyers or other devices used to transport either the finished products or parts which make up the finished products. As a multi-input flowmetering system it is pointed out that the application need not be limited to aircraft but might be applied to oil refineries or pipe-line installations where separate input signals might be miles apart. It is perfectly feasible to transmit differential synchro signals over distances of three to five miles without any appreciable error. By special installations these distances can be increased.

Materials Handling

Level Luffing Cranes for American Industry, by R. J. Stoddard, Mem. ASME, American Hoist and Derrick Company, St. Paul, Minn. 1951 ASME Fall Meeting paper No. **51—F-32** (mimeographed).

THE unique characteristic of the level luffing crane, a European development for cargo handling, has been adapted for use by American industry. In contrast to the slow booming motion of the conventional crane now used in America, this crane booms (or "luffs") at speeds comparable to the trolleying motion of bridge cranes. The term "level luffing" is used because of the crane's characteristic of transporting the load in a horizontal plane as the boom radius is changed. As a result, relatively little power is required for this motion and high speeds can be obtained. In conventional cranes the booming motion involves a vertical displacement of the load which requires considerable power. Consequently high booming speeds are neither safe nor practical in this type of crane. Level-luffing-crane booms are usually designed to be crank or rack-and-pinion operated and therefore are not subject to the usual hazards of dropping, overlowering, or overraising. Such cranes permit rapid, safe handling of loads by semiskilled operators. In practice a virtually straight-line motion of the load from the loading point to the discharge point is obtained by simultaneous swinging and luffing. This paper presents cranes for handling bulk or packaged materials in three fields, namely, ships' cargo service, industrial-plant service, and construction work.



a *b*

TOPLIS LEVEL LUFFING GEAR

(*a*, Rope luffing type; *b*, crank luffing type.)

Engineering and Design of Farm Machinery, by C. E. Frudden, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1951 ASME Fall Meeting paper No. **51—F-31** (mimeographed).

THE present trend in tractors and implements is toward a basic tractor, engineered to conform to the requirements of growing an almost endless variety of crops, particularly those grown in rows like cotton, soybeans, and corn, which require cultivation after the crop has grown to a considerable height and, therefore, high clearance under axles as well as means for adjustably spacing the wheels to fit the crop rows. Such a basic tractor then becomes a carrier, as well as a portable power plant, for many implements among which are plows suspended from the rear of the tractor, disk harrows similarly suspended, planters either ahead of or behind the rear wheels, cultivators both ahead and behind tractor rear wheels, corn pickers, and many other combinations. Other implements which receive their power from the tractor, such as combines, forage harvesters, hay balers, mowers, and rakes are carried on their own wheels and are hauled behind the tractor.

Designing farm machines with maximum versatility of use rather than for a single purpose may not be ideal engineering, but it is generally excellent economics. A modern combine harvester, for example, with a wide range of adjustments and an assortment of component parts, has no trouble in threshing 100 or more different kinds of grass and grain seeds varying in kernal size from tiny clover to big lima beans. Such versatility, on many a farm, means that one combine will be called into action three or four times during a season and, thereby, increases its use factor materially.

Forage harvesters are also designed for versatility. They cut the standing hay or corn and chop it into short lengths and are designed to handle crops in the following four ways: green grass for grass silage, corn for corn silage, dry or semidry chopped hay for delivery to hay mow, and chopped straw for bedding.

These variations in attachments for one base machine greatly improve the otherwise low use factor of this equipment and thereby make possible larger production runs for the manufacturer as well as greater usefulness of the machine in the hands of the farmer.

Engineering and design of machines are always influenced by the possible production volume attainable in manufacture. In this respect, farm machinery may be said to have reached the mass-production stage making possible the many economies that are associated with production in large numbers. For example, during the year 1950 there were produced in the United States more than 498,000 wheel-type tractors, 247,000 tractor cultivators, 174,000 tractor mowing machines, 341,000 tractor-type plows, 60,000 pick-up-type hay balers, 88,000 corn pickers, and 116,000 combine harvesters.

Some of these items are in production the year round, while other items, of a more seasonal character, are built in large runs of shorter duration. In either case, their engineering and design must be closely integrated with the latest production techniques in order to produce parts of high quality, strict interchangeability for manufacture and service, and at the lowest possible cost.

Coal and Ore Transfer From Rail Car to Lake Vessel, by E. E. Bauer, Heyl and Patterson, Inc., Pittsburgh, Pa. 1951 ASME Fall Meeting paper No. **51—F-14** (mimeographed).

THE problem of transferring coal from hopper-bottom rail cars into lake vessels at 3000 tons per hr and with an absolute minimum of degradation of coal has been solved with a unique combination of equipment tailored to the job. The installation is designed for growth and has proved its versatility by handling 1,000,000 tons of ore in the winter of 1951.

Since degradation is caused by dropping coal from great heights, the rather obvious solution is to minimize the free fall of the coal at any point. Experience with the lake dumpers and various utility installations dictated the use of a telescopic-type chute with a trimmer gate so that the coal would slide from its highest point into the lake vessel rather than fall into it as in accordance with previous practice. Furthermore, the telescopic chute offers additional versatility in that it can be rapidly positioned over the lake-boat hatches, it can be raised and lowered as the hold is filled, and it can be designed to move readily from inboard to outboard for even and maximum loading of the hold. A proper trimmer gate will allow the directing of the coal to the far corners of the hold, thereby providing the maximum possible loading of the vessel which had been impossible heretofore.

In order to properly feed a telescopic chute so that it can fulfill its function, it is necessary to have a surge bin or funnel at the top of the chute. Normally, this is spoken of as the "pan."

In considering the existing equipment and the necessity for economy, it was decided that the existing belt conveyer and car shakeouts be retained as elements of the initial installation. This also preserved the track layout in the yard with a minimum of change. Two shakeouts were available at the main plate feeder, and in order to provide sufficient capacity, a third unit was added. It was also necessary to modernize the main No. 1 conveyer to handle this additional capacity; therefore a completely new drive was designed for this conveyer. In establishing the capacity of the equipment, it was first decided that an ultimate goal for one unit and the existing dock would be 5,000,000 tons of coal in a season. A season was assumed to be approximately 270 days' duration, and the average boat capacity to be 10,000 tons. This meant that it would be necessary to strive for an average of almost two vessels per day. With the dock rail facilities that were available, it would have been almost impossible to schedule vessels so that more than 50 per cent of a 24-hr period could be available for actual loading. This, in turn, meant that each vessel would have to be loaded in approximately six hours' time. It was also necessary to approximate the dock loading and handling efficiency at around 60 per cent. This factor includes delays of vessels in arriving as well as delays in receiving and handling trains. It is interesting to note that in the 1950–1951 season 225 boats were loaded and 51,250 rail cars were handled. Sixty per cent of 6 hr would be 3.6 hr free loading time. This indicated an equipment capacity rating of approximately 2800 tons per hr. Since capacity would also be affected by the condition of the coal as well as the size and type of coal, an additional safety factor was introduced, and a nominal design capacity was established at 3000 tons per hr. Belt sizes and speeds, motor drives, and all other equipment were selected on this basis.

Steam Power

Steam-Generating-Unit Designs for Burning Coals From the Northern Great Plains Province, by John H. Cruise and Otto de Lorenzi, Fellow ASME, Combustion Engineering-Superheater, Inc., New York, N. Y. 1951 ASME Fall Meeting paper No. **51—F-33** (mimeographed).

THIS paper places major emphasis on the application of chain and traveling-grate stokers for burning lignite and subbituminous. Also discussed are fuel characteristics of the Northern Great Plains Province as well as the use of underfeed stokers, spreader stokers, and pulverized fuel.

Until about 1922 the natural-draft type of chain-grate stoker was widely used for free-burning fuels including those having high moisture content and severe weathering characteristics. Furnaces of the front-arch type are generally used with the natural-draft stokers. Efforts to burn lignite on forced-draft stokers installed in front-arch furnaces did not prove to be very successful. In 1928 two identical boilers were installed at Mobridge, S. Dak., one equipped with a forced-draft traveling-grate stoker set in a combination-arch furnace and the other with the same type of stoker in a rear-arch furnace. Tests showed practically no efficiency difference below a grate liberation of 275,000 Btu per sq ft per hr and an advantage of more than 10 per cent for the rear-arch design at a liberation rate of 350,000 Btu per sq ft per hr.

The latest type of rear-arch design is represented by a unit installed in the Estevan Steam Plant of the Saskatchewan Power Commission where Souris lignite bug dust is the fuel. The long low arch is of the water-cooled refractory type and the furnace front wall is completely water-cooled with fin tubes which have a refractory covering over the lower 15 per cent. Designed for a maximum steam capacity of 80,000 lb per hr, the unit demonstrated that it could easily be operated at rates in excess of guarantees. The results of a test at 86,000 lb per hr show an efficiency of 73.7 per cent adjusted to 500 F exit-gas temperature with a corresponding grate liberation rate of 336,000 Btu per sq ft per hr.

The performance of the Estevan units has demonstrated that where traveling-grate stokers are used the rear-arch furnace assures satisfactory operation with low-rank fuel. The fully ignited and active fuel bed contrasts sharply with the darkened front drying zone so typical of the combination-arch furnace. High velocity flow of gas from under the rear arch produces a rolling turbulence which promotes rapid moisture evaporation, stabilizes ignition, eliminates stratification, and insures uniform composition of gas entering the boiler surfaces.

For units up to approximately 200,000 lb per hr either traveling-grate or spreader stokers may be selected. In the range starting from 75,000 lb per hr, pulverized-coal firing should receive careful consideration. One advantage of the latter is the ease of switching to other fuels, a factor of significance now that North and South Dakota are in the ranks of petroleum-producing states.

Trends in Application of Deaerating Heaters for Treatment of Boiler Feedwater, by V. J. Calise, Mem. ASME, and R. K. Stenard, Graver Water Conditioning Company, New York, N. Y. 1951 ASME Fall Meeting paper No. **51—F-39** (mimeographed).

EIGHT case histories are presented, four from industrial power plants and four from central stations, which cite considerations in the selection and application of correct designs of a number of types of deaerating heaters. Each industrial case study included an analysis of the following factors: (1) Thoroughfare versus nonthoroughfare arrangement of steam and water flow relative to each other. (2) Internal versus external tubular vent condensers. (3) Tray versus spray deaerating heaters. (4) Materials of construction. (5) Amount of deaerated water storage.

One distinction between operation of deaerating heaters in industrial plants and in central stations is that operating pressures in the latter are generally higher. In addition, central-station heaters usually employ steam extracted

directly from one of the bleed stages on the turbine, and their heat cycles are such as to require close control of deaerating-heater-steam operating pressure and temperature. When turbine load falls off rapidly, there may be cases when the drop in extracted-steam pressure on the heater results in an operating pressure below atmospheric pressure. Under these conditions noncondensable gases must still be removed from the heater by proper venting.

Automatic ejecting equipment may be employed to create a vacuum and remove noncondensable gases from the heater when extracted steam falls below a fixed point. Another method is to use a pressure-reducing valve to supply steam to the heater from one of the higher turbine bleed points or to supply steam directly from a boiler header through a pressure-reducing valve. A third method is to maintain a constant low pressure regardless of load fluctuation, while a fourth is to use turbine condenser vacuum for discharging noncondensable gases.

Progress in Development of Process-Steam Turbines for Industry, by A. D. Somes, Mem. ASME, General Electric Company, River Works, West Lynn, Mass. 1951 ASME Fall Meeting paper No. 51—F-34 (mimeographed).

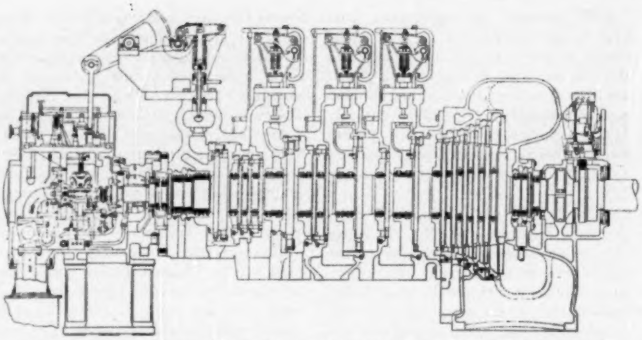
BY generating steam at a pressure above the process level and using the expansive energy in a turbine, power can be produced at a very low incremental fuel rate. Where steam must be generated to serve the needs of the process, by-product power can be made by a process turbine at an additional consumption of approximately 4250 Btu per kwhr in the case of a paper mill having a 1200-ton production per day and a power load of about 40,000 kw. This may be compared with 11,500 Btu per kwhr for prime power in an equivalent plant. While there is an increase in plant investment because of the higher-pressure and temperature equipment, the increased cost per kilowatt of capacity is generally only a fraction of that for prime generating equipment.

Basically, the process turbine accommodates itself to the steam flows required by the process while extracting as much power as practical. On small turbines a single throttling valve is frequently used for control. However, greater efficiency and increased output are obtained from multiple sectionalized nozzle control valves.

In some plants steam may be available at a given pressure in excess of process needs at that pressure. It may then be used in a process turbine exhausting to a lower process pressure or to a condenser, or it may be inducted into another turbine in the reverse operation of extraction. Most automatic extraction turbines can be modified to take in a limited amount of steam in this manner.

Process and power-balancing turbines may be effectively combined into a single unit to form an automatic extraction or parallel-flow turbine. In industrial plants, the automatic extraction turbine is the most frequently used type. The advantages of combining several elements into a single unit are: (1) lower cost, (2) less space, (3) reduced losses, (4) higher average output with widely varying flows, (5) co-ordinated and simplified control, and (6) less hazard of outages.

Single automatic extraction turbines were in use as early as 1914, and double automatic extraction turbines in 1925. The first triple automatic extraction turbine is expected to be placed in service in 1951. Because of unusual plant conditions it is actually arranged for the induction of steam at the upper point and will normally operate with steam being passed into the machine rather than extracted. The machine has a capacity of 10,000 kw, with inlet steam at 1250 psig, 950 F, and exhaust at 2 in. Hg. Steam is also admitted at 400 psig and extracted at 150 and 80 psig.



GENERAL ELECTRIC STEAM TURBINE FOR TRIPLE AUTOMATIC EXTRACTION OF STEAM

Lubrication

Serviceability of Paper-Mill Lubricants, by M. L. Langworthy and B. Weetman, The Texas Company, New York, N. Y. 1951 ASME Fall Meeting paper No. 51—F-35 (mimeographed).

A PAPER machine may be considered as consisting of the following two distinct parts in respect to the lubrication requirements:

1 The wet end where the paper stock which is composed largely of water is flowed onto a "wire" which carries it over a series of rolls and suction boxes, each of which aids in the removal of some of the water.

2 The dry end where the embryo paper is finally dried and calendered.

At the wet end the wire, which is an endless fine copper, bronze, or stainless-steel screening, carries the paper stock over the table rolls, over the suction boxes, and under a lightweight "dandy" roll which smooths the partially dehydrated paper. The sheet then passes between a set of couch rolls which squeeze out more water. At this point the paper can support itself and the wire returns to the start of these operations over return rolls located beneath the table rolls. The sheet is now transferred to an endless woolen felt which carries it between the press rolls where variable pressure is exerted depending on the desired dehydration at this point. The drier section of the machine which consists of a large number of steam-heated rolls completes the dehydration process.

The lubrication of the bearings of the many rolls in the wet end is extremely important from the standpoint of preservation of the wire and insuring an even feed of stock to the machine. While a number of these bearings on existent machines are of the plain or sleeve type, there has been a general trend to install ball or roller bearings in this service. The former could be either oil or grease-lubricated but the newer antifriction bearings require grease lubrication. The problems that confront the engineers in lubricating these bearings arise not from high loads or temperatures but from contamination of the lubricant with water which often contains paper fibers.

In the selection of lubricants for any unit as large and complicated as a paper machine, one must consider the desirability of maintaining the number of

products to a minimum. This not only facilitates the work of those charged with the responsibility of applying the lubricants, but also minimizes the danger of applying the wrong lubricant which may result in costly shutdowns. Greases selected should have the following characteristics:

1 Water resistance. This is considered mandatory for the lubrication of wet bearings where there is always a danger of water contamination which breaks down the structure of greases made with water-soluble soaps.

2 High-temperature stability. Since it is desirable to use the same grease on wet and dry ends of the machine, its heat stability should be sufficiently good to guarantee satisfactory performance on those bearings operating at elevated temperatures.

Lubrication of Flour Milling Machinery, by C. A. E. Gower, Socony-Vacuum Oil Company, Inc., Kansas City, Mo. 1951 ASME Fall Meeting paper No. 51—F-42 (mimeographed).

MILLING and processing requirements vary considerably and because of the different kinds of crops grown in various sections of the country, problems peculiar to that particular section are encountered.

A typical plant layout consists of cleaning and preparation, milling, and packing with the necessary auxiliary functions for servicing and maintenance. While problems in plant operations may be introduced because of local conditions, the lubrication requirements generally are very similar and the factors influencing the selection and application of a suitable lubricant are always present, varying only in degree as they affect the lubrication demand.

This paper reviews these factors as influencing machine lubrication which in turn exercises a material influence upon production flow and maintenance expense. Also included are those functions of servicing and maintenance that enter into the lubrication program and overall plant-lubrication efficiency.

Equipment includes car unloaders, elevators, belt and screw conveyers, screens, washers, driers, scourers, separators, and aspirators.

Production

Tool Control for Lot-Size Production, by W. Hubbes, Kearney and Trecker Corporation, Milwaukee, Wis. 1951 ASME Fall Meeting paper No. 51—F-38 (mimeographed).

IN the past much time had been lost in locating and obtaining proper tools to perform specific operations. In conjunction with a change to an incentive pay system, which highlighted lost-time delays, it was deemed advisable to establish an improved tool-control system. This improved tool-control system requires the following: (1) Specification of all tools used on each recurrent operation, (2) identification and control of location of all tools, (3) establishment of record data for location of tools when in use, (4) control of inspection and reconditioning of tools, and (5) establishment of procedure for obtaining and returning all tools.

Since it is uneconomical to set aside and store in the tool crib a complete set of tools for each and every part being machined in small to medium lot sizes, it was felt that all tools should be placed in one of three following categories:

1 Jig-room tools—special jigs, fixtures, and cutting tools which are necessary to machine a certain piece of work.

2 Tool-crib tools—standard perishable tools, such as drills, reamers, taps, etc., which can be used on many jobs.

3 Department tools—standard vises, angle plates, sleeves, and machine attachments normally kept at the machines in a department.

Single-purpose machinery or special tooling frequently permit more economical output. For example, production and accuracy requirements justified the design and construction of a special boring machine to bore several sizes of milling-machine columns.

Petroleum Mechanical Engineering

Fatigue Tests of Piping Components, by A. R. C. Markl, Tube Turns Inc., Louisville, Ky. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-21 (mimeographed; to be published in Trans. ASME).

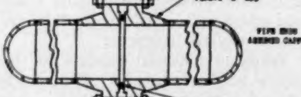
THE results of over 400 individual fatigue tests on full-scale 4-in. IPS assemblies involving piping components of various shapes and proportions conducted in the laboratories of the author's company over the past five years are summarized in this paper. Similar information published by other investigators here and abroad has been used to supplement the findings of this research and the combined data have been analyzed in an effort to develop correlations intended to enlarge the scope of application of the test results to a wider range of sizes and proportions.

The primary use of the data is to provide design constants for the analysis of stresses caused in piping systems by thermal expansion. Those familiar with this problem will agree that such analyses, however precise from a mathematical standpoint, never give more than an approximate estimate of the stresses due to the many assumptions which have to be introduced either because accurate information on operating conditions or physical constants is unavailable or conditions are too complex to permit solution within a reasonable time.

Considering that flexibility calculations are burdensome and time-consuming and nevertheless produce only approximate results, it would appear unwarranted to place undue emphasis on accuracy in the evaluation of stress-intensification factors, even if the data were available; on the other hand, to ignore them entirely is not permissible, at least where they assume large values or the service is definitely cyclic. The procedure proposed in the paper attempts to achieve balance between these opposing considerations.

Interaction of Pressure and Bending at Pipe Flanges, by Robert G. Blick, Sun Valley, Calif. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-9 (mimeographed).

THE gasket constant *m* is a dimensionless constant. It has been found that the pressure on gasket faces required to avoid leakage must bear a minimum ratio called *m* to the hydrostatic pressure expected to be confined. The value of *m* depends on the type of gasket material and the initial pressure to which the gasket is installed. It also depends on the type of flange facing used, but the methods of design usually account for this by choosing an "effective" gasket width. This term *m* is linked to the way the "total hydrostatic end load" (which is the pressure load tending to pull the assembly apart) is computed. When this total



CONVENTIONAL FLANGED ASSEMBLY

hydrostatic end load is computed by multiplying the pressure by the area of the diameter of the "center of the effective gasket pressure width" as in the API-ASME Code for Unfired Pressure Vessels, 1943, m should be called the effective ratio. m is not the same as r, the contact pressure ratio mentioned in the 1936 issue of the Code. Nor is it the same as an absolute pressure ratio (which may be designated m_a). The terms r, m, and m_a depend on total hydrostatic end loads based on, respectively, the outside diameter, the mean diameter, and the inside diameter of the gasket.

In the final analysis, narrow gaskets make the exact choice of m values less important. Narrow gaskets tend to make more efficient pressure seals, from the point of view that a smaller percentage of the total pressure area is involved. They also make G, the diameter of center of effective gasket pressure width, more compatible with simplified formulas, as have been used in this paper. The fundamental problems then reduce to determining (1) good criteria for gasket crushing, (2) good criteria for gasket "blowout," and (3) for wide gaskets used with flexible flanges, effective m values taking account of nonuniform gasket pressure distribution across the gasket width.

The Stresses in a Pressure Vessel With a Conical Head, by G. W. Watts, Fellow ASME, and H. A. Lang, Standard Oil Company (Indiana), Chicago, Ill. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-8** (mimeographed).

THIS paper presents the results of computations for determining the stresses in a pressure vessel with a conical head. The accurate bending theory of shells is used to evaluate the local bending stresses in the neighborhood of the junction of the conical head and the cylindrical body. Tables show the magnitudes of the shear stress, the circumferential stress, and the axial stress at the junction as multiples of $pd/2t$. Additional results show the magnitude and location of the maximum stress (of each of the three types) in the cylinder. Curves are given showing the maximum stresses for values of cone apex angle, ratio of conical-head thickness to cylinder thickness, and ratio of cylinder diameter to cylinder thickness which will include most of the vessels encountered in practice.

Tables of influence numbers for the conical head are presented. These can be utilized in many problems which require attaching a conical shell to some other elastic structure. A discussion of the mathematical procedure is contained in an appendix.

A New High-Yield-Strength Alloy Steel for Welded Structures, by L. C. Bibber, J. M. Hodge, R. C. Altman, and W. D. Doty, United States Steel Corporation, Pittsburgh, Pa. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-5** (mimeographed; to be published in Trans. ASME).

THIS paper concerns a new kind of steel, its development, its metallurgical characteristics, its welding and gas-cutting characteristics, its low-temperature toughness, its applications, and its engineering potentialities.

This steel was developed by the United States Steel Company to offer to industry a plate steel having a unique combination of properties, such as far higher strength than has hitherto been available, superior toughness, and good weldability. The test results indicate that these rather formidable goals have been achieved. This new USS "Carilloy" steel has been designated "T-1". It is characterized by yield strength levels of 100,000 psi and above. At high strengths it retains its toughness to much lower temperatures than ordinary structural steels. In addition, welds which develop the full strength of the base metal can be made in T-1 steel without preheating or post-heating.

The most important metallurgical characteristics of this steel are its microstructure and its carbon content. The microstructure is tempered martensite and the carbon content is low—less than 0.20 per cent. The superiority of this steel in strength, weldability, and toughness is largely a reflection of these two factors.

The Development of Metal Arc Electrodes for Special Welding Applications, by J. J. Chyle and R. J. Keller, A. O. Smith Corporation, Milwaukee, Wis. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-2** (mimeographed).

IN the search for constant improvement in the various types of electrodes, it is important that a continuous program of development be maintained at all times. The development of any electrode is never complete, and there is always a goal of still further improvement, either in the operating characteristics of the electrode or in the quality of the weld metal itself.

This presentation gives a typical illustration of how special electrodes are developed in three different industrial applications, namely, the development of an electrode for use in welding automotive parts, an electrode for welding high-pressure high-temperature steam-power-plant piping, and an electrode for welding natural-gas-transmission pipe lines. Today, dozens of special-application electrodes are used in such industries as aircraft, or in the chemical industry where special stainless steel or other electrodes are continually being pursued. The need for new types of electrodes is greater today than it has been in the past as new products are developed, new metals and alloys are being used, and the stress for greater economy is mandatory.

The process of development of electrodes involves considerable effort on the part of both producer and consumer. The economics of the development of a special electrode must be given consideration since a special electrode cannot be developed for low-volume consumption as the cost of the development must be included in the price of the electrode.

It is believed that a sound program of welding-electrode development will result in an improvement of weld quality, reduce fabricating costs, and make possible the use of new metals and alloys. This result can be accomplished only by the co-operation and integration of the efforts of the manufacturing, engineering, purchasing, and sales departments of both the user and producer of welding electrodes.

Graphite-Impregnated Rubber Packing for Reciprocating Pumps and Oil-Well Stuffing Boxes, by Edward T. Skinner, Jun. ASME, Skinner Brothers Rubber Company, Dallas, Texas. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-17** (mimeographed).

THIS paper explores the use of graphite-impregnated rubber as a possible material for making mechanical rubber goods subjected to abrasive wear, e.g., gland packing for slush pumps.

The value of graphite as a lubricant has been known for a considerable period of time. It works well as a lubricant by itself as well as in oil. If the graphite could be mixed in sufficient quantities into the rubber packing used to prevent a fluid leak around a moving part, it is possible that a considerable power saving and a longer life for the packing could be realized. It might also provide for a graphite-coated metal part which should reduce, at least to some extent, the tendency of the metal part to corrode.

Tests were made on rubber packing used on oil-well stuffing boxes and slush-pump packing glands under field conditions. When the rubber packing is properly made, considerably longer packing life is obtained in field tests.

It was found that graphite, flake or amorphous, can be used as a rubber addi-

tive in mechanical rubber goods provided that the amount of graphite added gives sufficient lubrication without detracting too much from physical properties of the rubber. The optimum quantity of graphite to be used will apparently have to be worked out for each application.

Vinyl Resin Coatings in Petroleum Refineries, by C. G. Munger, Amercoat Corporation, South Gate, Calif. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-11** (mimeographed).

VINYL resin coatings are, for the most part, classed as specialty coatings or coatings for specific and difficult conditions. In the refining of petroleum, because of the tremendous structures required, the large areas of exposed steel surfaces and because of the extreme range of conditions found in refineries, the need for special coatings and for coatings which will withstand severe chemical, temperature, and weather abuse, is great. The design of refineries has, from the beginning, tended toward the modern openwork structure for equipment where the structural steel is exposed to the weather and all of the complicated pipe systems and specialized processing equipment are subjected, not only to the weather but to all of the refinery fumes, steam, high humidities, and, in coastal areas, salt air as well.

Many of the fumes involved are extremely corrosive, such as sulphur dioxide, hydrogen sulphide, hydrogen fluoride, and ammonia. When materials such as these are combined with steam or high humidity, high corrosive conditions are developed.

Vinyl resins have the basic resistance and chemical properties required for refinery corrosion. They are formulated for maximum utility from single-solution coatings for fume conditions, to system coating for severe chemical immersion, or they may be applied as molded linings where the maximum resistance is required. They are applicable not only to new installations but are readily applied in the field by standard paint equipment and require care only in order to obtain an impervious film. The vinyl coatings have been proved by actual application to operating equipment in some of the most severe refinery exposures.

Techniques of Cost Estimating for Refineries, by Robert P. Wilson, Mid-Continent Petroleum Corporation, Tulsa, Okla. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-10** (mimeographed).

BUSINESS management has as its major purpose making a profit for its investors. The ultimate purpose of a cost estimate is to provide management with the information it needs in order to spend available money in a manner which will provide the maximum return with due consideration being given to the safety of the original capital investment.

In this paper the detailed cost estimate of a refinery project is considered from the standpoint of (1) what constitutes reasonable accuracy, (2) what information should be available in order to make an intelligent estimate, and (3) the techniques used in preparing the actual estimate.

According to the paper, the following should be done: First, find out what is to be done—obtain flow diagrams, plot plans, utility surveys, and the specifications of materials to be employed. Second, break the job down into comprehensible items. Third, estimate the costs of individual items and summarize these costs. Fourth, prepare a revised estimate, if consideration is long delayed. Finally, to improve technique, compare final job costs with originally estimated costs.

Nordberg Supairthermal Diesel, Dual-fuel, and Gas Engines Operating on the Miller Supercharging System, by Ralph Miller, Mem. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-24** (mimeographed).

THE Nordberg Supairthermal dual-fuel engines can be operated either with pilot or spark ignition. An engine of this type is now being installed in a municipal power plant in a western state. These engines operate with the same high thermal efficiency as the Diesel engine. They are rated at 160 lb bmep for continuous heavy-duty service. Being intercooled, they are not subject to detonation difficulties due to high ambient temperatures.

The Miller System of variable-compression-ratio supercharging has also been developed for two-cycle engines of the uniflow and opposed-piston type. The gain in hp output and efficiency over the conventional type of engines is even greater than shown for four-cycle engines, being on the order of 50 per cent increase in output and 14 per cent reduction in specific fuel consumption. The results are obtained without increasing the heat flow to water jackets per unit time, which means internal surface temperatures or the maximum combustion pressures, which are now established and accepted in conventional two-cycle engines at full load rating.

Modern Trends of Automatic Control in the Refining Industry, by V. V. St. L. Tivy, Jun. ASME, The Foxboro Company, Foxboro, Mass. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-22** (mimeographed).

THE paper starts with a general review of developments in instrumentation and automatic control engineering over the past 20 years, and traces in retrospect two definite trends in development work. The development of control devices and the development of measuring devices are shown to have followed two definite cycles.

It is pointed out that because of the gradual trend of development, full advantage of each improvement has not always been taken in respect to the over-all performance of the system. An examination is made of the available tools for instrumentation and automatic control, and a number of suggestions made as to how vastly improved performance of refining units can be obtained by different usage of the several available mechanisms for measurement and control.

Following the line of reasoning developed, new equipment is introduced, explained, and its place in the general field of instrumentation pointed out. The paper, in general, is written in nontechnical language and should stimulate thinking on the part of refinery process designers and operators.

A Small-Scale Plant for Studying Catalytic Reactions at High Pressures and Temperatures, by C. M. Sliepcevich and G. G. Brown, Jun. ASME, University of Michigan, Ann Arbor, Mich. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-20** (mimeographed).

IN recent years, and particularly since World War II, there has been a tremendous increase in activity in the field of high-pressure high-temperature processing. Today many new companies, particularly in the petroleum industry, have entered this field. With this trend has come the need for increased fundamental investigations by research laboratories all over the world.

Future work points to still higher pressures and temperatures. New problems on the design and construction of suitable equipment for making preliminary studies are being encountered.

The purpose of this paper is to describe a small-scale continuous plant for studying catalytic reactions at high pressures and temperatures. This plant has given satisfactory service with practically no maintenance difficulties over the past three years. The most extreme condi-

tions of operation have been 10,000 psi at 1200 F. Present plans call for operation of this plant at 20,000 psi and 1000 F.

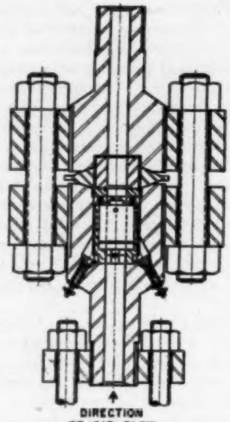
Studies on the catalytic decomposition of butyl alcohol have demonstrated that this plant can be satisfactorily operated over a wide range of pressures, temperatures, and feed rates ("space velocities"). It is estimated that even at present-day prices a similar plant could be constructed at a cost of $5000–10,000, depending on the amount of instrumentation desired. (Approximately $3000 is allotted for the purchase of a high-pressure pump or compressor.)

Performance of High-Pressure Instruments in the Bureau of Mines' Synthetic Fuels Demonstration Plant, by C. E. Balcerzak and J. A. Skillern, Bureau of Mines, Louisiana, Mo. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-7 (mimeographed).

THE Bureau of Mines Coal-Hydrogenation Demonstration Plant at Louisiana, Mo., has made five liquid-phase and one vapor-phase runs during the past year. On the basis of the operating experience thus developed, this paper describes the effects of vapor pressure, viscosity, gas density, and other factors on the measurement and control of process variables at high pressures. It also gives an account of several important control changes required to produce a stable process, and shows the disposition of the special high-pressure instruments developed for use in this plant.

Experience with high-pressure-range instruments indicates that standard service-tested instruments were most dependable. In many cases, changes to meet the special needs of the application were required but basically the instruments met the design specifications. This group includes pressure indicators and transmitters, differential mercury manometers for flow and level, temperature-measuring instruments, and control valves. Newer instruments developed for high-pressure applications have had limited success. Most of these incorporate some very desirable features, but in all cases are less dependable than the standard applications.

However, this account also indicates that a high-pressure instrumentation program for the future must include provisions for satisfying the following needs: (1) Bourdon elements of pressure transmitters to be mounted so as to be free of piping strains; (2) quicker response to temperature changes in heavy-walled tubes and vessels; (3) solution to the problem of mercury emulsification in flowmeters; (4) dependable and continuous method of accurately measuring differential pressures, ranging from 100 to 1000 lb.; (5) more development work on instruments applicable to high-pressure service; (6) in general, a more critical approach to the measurement of process variables at high pressures than that applied to instrumentation of processes at ordinary pressure levels.



ASSEMBLY OF HIGH-PRESSURE FLOW INDICATOR

Valves to Combat Corrosion, by Jack W. Harris, Cameron Iron Works Inc., Houston, Texas. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-27 (mimeographed).

THE design of valves suitable for use in handling the corrosive products of condensate wells has evolved during the relatively brief and successful fight against equipment damage occurring in this service. Several logical approaches were made to the problem, but met with only partial success. A new theory in valve design was advanced several years ago, however, and the products designed in accordance with this theory have proved to solve the major problems arising in the design of valves for this and other types of corrosive services.

Early findings by the NACE and NGAA committees showed that certain materials would definitely resist corrosion attack in condensate well service. Unfortunately, these materials were both expensive and lacked the physical properties required by API. This did not, however, exclude their use as linings or coatings, and it was in this direction that early efforts were made to provide the corrosion resistance required in valves for this service.

The first valves designed to resist corrosive attack were equipped with thin metal sleeves or sheets which were formed to fit the body cavity and other critical sections of the valve. These sleeves were welded in the valve to assure their continued proper location, but in the case of plug valves, considerable difficulty was experienced in maintaining the close fits and tolerances required to assure proper operation of the valves. Field experience with this type of construction proved it to be unsatisfactory because any leak in the weld, or leaks caused by corrosion of unprotected surfaces, permitted the corrosive material to attack the parent surface of the pressure cavity and undermine the lining.

It was felt then that by undercutting the critical surfaces in a valve and then welding or laying a welded coating of corrosion-resistant metal on those surfaces, the bonding problem would be eliminated. In the case of plug valves, this seemed to be a more desirable method too, since machined surfaces having critical tolerances and finishes would be as rigid and as satisfactory as those in standard valves. Of particular importance in this type of lining is the care necessary in the selection of materials to coat mating surfaces so that galling will not occur. This aspect of the problem was alleviated somewhat by the use of Stellite, Hastelloy, and certain other corrosion-resistant materials which could be hardened to minimize the possibility of galling or "freezing." This method, although quite expensive, proved to be entirely satisfactory provided uniform nonporous coatings were obtained. It is still being used by a number of valve manufacturers, mostly on plug or plug-type valves.

A third solution is to make the entire valve out of corrosion-resistant materials. Many manufacturers, particularly of gate and globe valves, follow this procedure. The initial cost of these valves is of course high, and with the materials situation getting more critical, the availability of valves made entirely of corrosion-resistant materials is poor. However, from an economic standpoint, such valves seem to be a good investment and many are sold for use not only in the oil field, but also in the process industries.

Natural-Gas Dehydration Using Triethylene Glycol, by Lawton, L. Lawrence, Black, Sivalls and Bryson, Inc., Oklahoma City, Okla. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-28 (mimeographed).

THE rapid expansion of the natural-gas industry has produced a demand for natural-gas dehydration in small pack-

aged plants which will meet the following requirements: (1) Low initial cost, (2) adaptable for small single-wall installations without a large increase in initial cost per unit of capacity, (3) operate efficiently with widely varying flow rates down to a small fraction of its rated capacity, (4) have a low operating and maintenance cost, (5) fully automatic and operated with a minimum of attendance, (6) simple enough for personnel with no processing-plant experience to operate and maintain, (7) dependable to give dehydrated gas at all times, and (8) dehydrate gas to pipe-line specifications under all conditions normally encountered in year-round operation.

The triethylene-glycol-type natural-gas dehydration system has proved in operation that it can meet the foregoing requirements in most installations.

1 The initial installed cost ranged from $1500 per MMSCFD of capacity for very small plants (1 to 2 MMSCFD capacity) to $500 per MMSCFD of capacity for larger plants.

2 It will operate with almost equal efficiency at flow rates ranging from 10 to 100 per cent of the rated capacity.

3 Operating costs range from 20 to 40 cents per MMSCF of gas processed.

4 Little maintenance is required.

5 Fully automatic with only an occasional operating check required.

6 All equipment of type with which most lease-operating personnel are familiar.

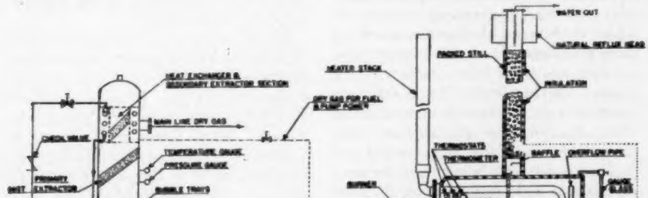
7 Will give dehydrated gas as long as the pump and temperature controls are functioning.

8 Will consistently process gas to a water content which meets pipe-line specifications in almost all conditions normally encountered where gas is being produced into transmission pipe lines.

Water-Cooling Towers and Air-Cooled Heat Exchangers in the Petroleum Industry (Selection, Operation, and Maintenance), by Howard E. Degler, Mem. ASME, The Marley Company, Inc., Kansas City, Kan. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-13** (mimeographed).

RECENT water crises in the Southwest, California, New York, and elsewhere in the U.S.A. have brought to public attention basic shortages of underground and surface water that engineers have been predicting for decades. The conservation and re-use of cooling water has become a necessity in these and other widely scattered areas, each of which has its individual problem of water supply and usage.

Large water users include power plants, refrigeration, and the manufacturers of petroleum products, chemicals, rubber, paper, textiles, rayon, linen, lactose, sugar, foods, liquors, explosives, hydrogen, steel, and many others. Water usage has doubled in the past decade and today's requirements of many process industries are frequently in excess of 300 lb of water per lb of finished product. Therefore the selection of the most practicable cooling method for re-use of water or its elimination as a coolant becomes more important as new processes are perfected, industries expanded, and power demands increased.



FLOW DIAGRAM OF GAS DEHYDRATION SYSTEM USING TRIETHYLENE GLYCOL AS DESSICANT

Mechanical-draft cooling towers can cool water by evaporation to a temperature approaching the wet-bulb temperature of the ambient air. This water-cooling method requires less than one per cent evaporation of the water circulated to economically dispose of the process heat load.

Air-cooled (finned-tube) heat exchangers are having increased acceptance and usage for "high-level heat removal" (e.g., above 130 F referred to 100 F dry-bulb air), where water is scarce, expensive, and/or badly polluted; low maintenance cost of control are other features.

ASME Transactions for November, 1951

THE November, 1951, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Symposium on Cooling Towers:

Some Economic Factors in the Selection of Cooling Towers, by A. R. LeBailly. (51—S-5)

Cooling Towers for Steam-Electric Stations—Economic Applications, by Louis Elliott. (51—S-6)

Selection, Operation, and Maintenance of Industrial Cooling Equipment, by H. E. Degler. (51—S-7)

Recirculation in Cooling Towers, by Joseph Lichtenstein. (51—S-8)

Operating Experience With Cooling Towers in the Central Gulf Area, by H. G. Hiebeler. (51—S-9)

Problems Relating to Operation, Maintenance, and Chemical Control of Cooling Towers for Steam-Electric Generating Stations, by V. F. Estcourt. (51—S-10)

Deterioration of Wood in Cooling Towers, by R. H. Baechler and C. A. Richards. (51—S-11)

The Hydrodynamic Lubrication of Sector-Shaped Pads, by R. S. Brand. (51—SA-6)

The Nonsteady-State Load-Supporting Capacity of Fluid Wedge-Shaped Films, by E. K. Gatcombe. (51—SA-5)

Aircraft Turbosupercharger Bearings—Their History, Design, and Application Technique, by S. R. Puffer. (51—SA-12)

The Fatigue Strength of Threaded Connections, by R. C. A. Thurston. (51—SA-11)

Comparative Surface-Hardening Characteristics of Commercial Pearlitic Malleable Irons, by S. H. Bush, W. P. Wood, and F. B. Rote.

Dynamic Force Reactions in Double-Ported Control Valves, by C. F. King and G. F. Brockett. (51—SA-1)

Metastable Flow of Saturated Water, by J. F. Bailey. (51—SA-55)

Intermittent Heating for Aircraft Ice Protection With Application to Propellers and Jet Engines, by Myron Tribus. (50—A-55)

Further Remarks on Intermittent Heating for Aircraft Ice Protection, by Frederick Weiner. (51—SA-38)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Engineering in Forest Protection

Comment by A. A. Brown[1]

The broad philosophy with which the author approaches the whole problem of forest protection is notable.[2] He is a planner with a purpose. The immediate purpose may be quite prosaic, but it is a part of a vision of promoting the conservation of natural resources through mechanization of the tough and difficult jobs that must be done to fight forest fires effectively. To turn the vision into reality he couldn't remain a philosopher and a planner; he had to become skilled in forest and woodland fire fighting, and he had to become a high-class technician and leader in designing, testing, and manufacturing machines. He has attained real stature in all these fields. In other words, the author, alone, has been functioning as the equivalent of a complete industrial-engineering staff from the front office down. Probably few engineers assume such a range of functions.

The Michigan Forest Fire Experiment Station, over which the author presides, reflects these things and is a distinctive institution in its field. Mechanical engineers who visit it find it so in the technical engineering field; others find new things, too. In keeping with the scope of his responsibility, the development of equipment to perform a very exacting function takes place at this center, beginning with an idea and following all the way through to manufacture in some quantity.

The forest fire-fighting bill of the United States amounts to $50,000,000 every year. Even with this effort the losses amount to just about an equal amount. So forest fire fighting is big business even in this country. Any one who can make it more efficient is playing for a big stake.

The development of equipment to make fire fighting more effective and more efficient has intrigued forest fire fighters in all parts of the country. Too often the limitations of machines and materials known so well by mechanical engineers were disregarded. So failures have been frequent. Yet, most of the advances made can be related to the success attained in mechanizing the job. The author has won an outstanding place in this effort through his work in Michigan. It is unfortunate that his talents have not been applied to forest-fire problems more generally throughout the United States. If that had been done a number of years back, it is certain that the costs and losses from forest fires throughout the country would have been reduced by many millions of dollars. As it is, the problem of effective mechanization which he describes so clearly for the Lake States, remains a challenge throughout most of the country to the talents and ingenuity of mechanical engineers of the highest caliber.

[1] Chief, Division of Fire Research, Forest Service, U. S. Department of Agriculture, Washington, D. C., and SAF Chairman of the ASME-SAF Joint Committee on Forest Protection.

[2] "Engineering in Forest Protection," by G. I. Stewart, Mechanical Engineering, vol. 73, June, 1951, pp. 477–480.

Comment by Ira C. Funk[3]

The author clearly presents several typical fire-equipment development problems and the professional manner in which the State of Michigan is attacking these problems. In the U. S Forest Service such work has been conducted in a manner varying from "backyard" experimentation up through and including those described by the author. The present trend is definitely toward the professional approach as this is the most satisfactory and economical in the long run.

It appears that the author is referring to equipment specifically made to meet a local problem, perhaps within the State of Michigan, when he says that the market is too limited to interest commercial development and manufacture. When one views the common problems over the nation as a whole and integrates the fire protection with other phases of forestry, what originally appears to be a very specialized item having a limited market often becomes an item of wide application with a good potential sales volume. In the past, industry has taken only a moderate interest in forest-fire protection equipment. However, with the growing demand for such equipment, alert businessmen are becoming more interested in developing and producing equipment for all phases of forestry.

We realize there will be some items that will not justify commercial development even from a national viewpoint. For these, forest-protection agencies will continue to depend upon their own equipment-development facilities.

[3] Division of Fire Control, Forest Service, U. S. Department of Agriculture, Washington, D. C. Mem. ASME.

Comment by R. B. Sargent[4]

Why is the fire pump mounted at the front of the tractor, driven from the tractor engine? If, as the writer assumes, it is desirable to drive the tractor through the woods and deliver a fire stream at the same time, does not every change in engine speed, every shift of gears, every declutching interfere with a uniform fire stream? Is this not a problem? Our experience with trucks and pumps designed for fighting grass fires indicates that it is. For this reason we prefer a pumping unit driven by its own engine. The fire stream delivered then is completely independent of the demands upon the tractor engine.

Has the author had the opportunity to experiment with a variety of fire-stream pressures? On the Pacific Coast there is a demand for 200 psi. Pressure of 600 and even 800 psi have been used, giving a fog stream. Many forest fires are still extinguished with fire streams from pumps operating at 75 to 100 psi. What is the author's experience in Michigan?

This timely paper is a clear, stimulating review of engineering problems faced by our forest-protection groups. It dovetails well with the current activity of the joint ASME-SAF Forest Protection Committee. The author's presentation convinces us that in the field of forest protection there is boundless opportunity for the exercise of engineering ingenuity and science.

Add to the problems and solutions presented in this paper applying to Michigan the equally specialized forest-protection problems of Maine, Georgia,

[4] General Manager, Hale Fire Pump Company, Conshohocken, Pa. Mem. ASME.

California, Washington, and all the states in between, and we expand the opportunities many times.

It would be expected that an engineering-development job, combined with the opportunity to work and play in the woods and fields, would be completely satisfying to many individuals.

We hope that this paper will influence more young engineering graduates to enter the forest-protection field.

Author's Closure

In reply to Mr. Sargent's comments, the problem of surging streams in most woods tankers or tractors when pumps are driven from a power take-off is taken care of to a great extent in the size of pump used. In this case, we use a pump of 50-gpm capacity and cut down the discharge by an adjustable gun to use not more than 10 gpm, which is usually sufficient. The balance is by-passed but constitutes a reserve of volume that can be used to maintain a steady stream. However, the disadvantage of surging streams, as pointed out, is a problem and is ever-present. Actually, we have developed two models of tanker tractors, one of which uses a gasoline-engine-driven pump, which of course follows Mr. Sargent's preference and dispenses with the power surge. Incidentally, this is the model we prefer rather than the power take-off arrangement. Declutching causes no trouble in this case because the pump is driven from the front and contains an independent clutch of its own. As long as this is engaged, the foot clutch has no influence on the continuity of pump operation, while the tractor engine is in operation. The by-pass is set at 200 psi and operates to by-pass water at much lower engine speeds than the normal ones in transit.

The second question dealt with necessary pressures. This is a much-argued point. Good work can be done with pressures as low as 80 psi, depending upon the types and quantities of fuel involved. We operate many tankers at pressures of 100 psi or less.

However, high pressure is very effective most of the time, and a given quantity of water will go further and do more work at high pressure than otherwise. With the power wagons we use pumps with pressures up to 600 psi, and two units even use 800 psi with adjustable guns. True fogs are not used much because they float in the wind. But streams of an open pattern with plenty of driving force do a marvelous job.

Our tractor-tanker outfits use pressures of about 200 psi, and the water is not depended upon solely to extinguish fire when plowing at the same time; it is used to knock down flames and to cool off hot fronts, enabling us to plow closer to burning edges than we could do otherwise.

However, when using trailers, the stream has to do all of the work but we think from experience thus far that 10 gal at 200 psi will handle the majority of the jobs. If we need higher volumes at any given time or for any particular job we can get this by a change in nozzles for the time required.

It happens that we often have to pick locations to make a stand at some hot front. At such times we use mobile tankers mounted on semitrailers that can move from point to point; also temporary setups of canvas or metal tanks, and the tractor tanker can be attached from one to the other for pumping as required. If time permits we can pump from wells at selected spots; and, of course, the use of trailer tankers that perform shuttle duty from refill points to pumping locations is standard practice.

Gilbert I. Stewart.[5]

[5] Supervisor, Michigan Forest Fire Experiment Station, Michigan Department of Conservation, Roscommon, Mich.

Scope of Your Profession

Comment by Chas. T. Paugh[6]

The author of this paper[7] expresses a thought with which I definitely agree and on which I would amplify considerably. Having behind me 35 years of varied engineering experience in industry, much in executive capacity, my viewpoint is supplementary to that of the author.

My initial engineering education was electrical but, at once, realizing its limitations, I added much in mechanical and civil engineering and chemistry plus an AB degree which totaled 6 years. I have wished it could be more. Later supplementary studies were in metallurgy, organic chemistry, aeronautical engineering, accounting, public speaking, and industrial management.

Specifically, segregated work in large organizations may involve only one branch of engineering or science but, in the many moderate and small-size plants, it is common for the engineer to become involved in almost anything, and he has a much better chance for advancement if he understands a wide variety of basic principles. Chemistry is becoming increasingly involved in industrial operations and in the modern power plant, while both electrical and mechanical engineering are of major importance. The supervising engineer of either design or operation is definitely handicapped if he does not understand the chemistry involved in water treatment, combustion, and corrosion. A general understanding of fundamentals of economics, accounting, effective speaking, and psychology of getting along with others is of essential importance to engineers expecting advancement as all should.

The modern trend to a minimum of 5 years for regular engineering courses seems unavoidably essential, and emphasis should be toward acquainting the student with practical conditions he will encounter and establishing proper habits of progressively learning and applying new knowledge which must be a continuous procedure during his career.

The trend for more industrial contacts and experience for professors is all to the good; and encouragement should be given to minimizing what frequently resembles caste segregation between, particularly, chemical engineers and others.

The modern habit of referring to scientists and engineers as though they were as distinctly different as physicians and lawyers seems to me to be as wrong as the segregation of different branches of engineering. Principles of engineering have their roots in the basic sciences and, conversely, those who restrict their work to essentially basic science frequently must use engineering principles for its application or to understand better the advisable trend of their developments.

All these things help point out the logic of the subject paper and desirability of its amplification.

[6] Utilities Engineer, U. S. Industrial Chemicals Company, Baltimore, Md. Life Fellow, ASME.

[7] "Take a Broad View of the Scope of Your Profession," by A. P. Adamson, Mechanical Engineering, vol. 73, August, 1951, pp. 649–650.

Comment by T. C. Reeves[8]

Mr. Adamson's recent paper citing the increasing interpractice of mechanical and electrical engineering is largely a statement of fact beyond disagreement. But as Mr. Adamson proceeds from this conceded premise to the conclusion that "Our college courses in EE and ME should be combined into one electromechanical engineering course" the writer finds himself in total disagreement.

The fact that different "kinds" of

[8] International Resistance Co., Philadelphia, Pa. Jun. ASME.

engineering are commonly required in today's practice is not justification for combining these different fields at the undergraduate level. The inevitable result of such combination would be an unworkably ponderous curriculum.

For example, besides being an electromechanical engineer, does not the mechanical engineer who designs and specifies equipment also have to be somewhat of an authority on metals, their microstructure, heat-treatment, fabrication, and finishing? If so, to properly prepare at the undergraduate level, it would be necessary to combine ME, EE, and Metallurgical Engineering. And the electromechanical engineer also has to know considerable about protective coatings, "plastics," electrolysis, corrosion, plating, and other aspects in the domain of chemistry. Including this important field, we should then have a combination ME-EE-Met. Eng-Chemistry course. An engineer should also know something of production methods, planning and control, motion and time study, and cost control. Accordingly, Industrial Engineering might be added to the combined curriculum as well.

Clearly, without further reductio ad absurdum, no undergraduate course in engineering can practicably touch on all the working facets of an active engineering career—not one course nor any combination of courses.

In four years, or five, or even six, schools can hope to impart only a small fraction of the knowledge required to cope successfully with vigorous engineering practice. The rest of that knowledge and, indeed, all the real know-how, must be accumulated by the graduate largely through his own resources. If he is resourceful, he will accumulate it. If he is not resourceful, a lifetime spent in all the engineering schools in the country will not compensate for this shortcoming.

If a young engineer lags behind in professional development, one should not be too concerned over what undergraduate course he took or in what school he studied. Rather, one should ask him, or he should ask himself, what he has done to promote his *own* development. Does he, for instance, belong to an engineering society? Does he attend and take part in the local activities of his society? Does he read all the technical papers published in its magazine or only those of his "specialty"? And does he conscientiously *read* such papers or does he merely glance over them, avoiding the fatigue of their intellectual digestion? Has he joined sister engineering societies to help broaden his scope even further? Does he seek to meet and discuss problems with other engineers of greater or different experience? Has he taken advantage of available local facilities for formal postgraduate training? Or, if formal facilities are unavailable, has he ever undertaken to teach himself a new phase of engineering? What, in short, has he done to help himself since graduation?

All these aspects of self-education are probably far more important in the long run than formal education. If the adequacy (or inadequacy) of undergraduate training were the major determinant of professional proficiency, the degree of uniformity found in curricula is so high that we would all be either chief engineers or junior engineers, depending on which extreme of importance we attach to college training. The fact is that there are some of both but more of one than of the other and the difference must be attributed to the personal equation, an equation largely beyond the influence of any college curriculum, however comprehensive or diverse that curriculum may be.

AUTHOR'S CLOSURE

The comments of Mr. Paugh and Mr. Reeves are appreciated. The author sincerely believes that undergraduate training should and does touch on a great many of "the working facets of an active engineering career." Even more facets can be touched on to a useful extent if undesirable specialization is abandoned. Above all, however, it is essential that the training be given in such a way as to allow the student to retain his interest in all fields of engineering. Undergraduate training as now presented does not fulfill this goal. As a result many young engineers who should follow a self-development program fail to do so.

Mr. Paugh's statement "...emphasis should be toward acquainting the student with practical considerations he will encounter and establishing proper habits of progressively learning and applying new knowledge which must be a continuous procedure during his career" provides an accurate summary of the author's thoughts on engineering education.

ARTHUR P. ADAMSON.[8]

[8] Aeronautic and Ordnance Systems Division, General Electric Company, Schenectady, N. Y. Jun. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Architects of Aviation

ARCHITECTS OF AVIATION. By Maurice Holland with Thomas M. Smith. Duell, Sloan and Pearce, New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^1/_4$ in., plates, index, ix and 214 pp., $4.

REVIEWED BY D. O. DOMMASCH[1]

THE modern aircraft plant is a truly impressive spectacle—large in size, stuffed with machinery, and frequently bursting with noise. From its doors emerge sleek fighters, heavy transports, secret missiles, heavy bombers, and the other complex products of modern aviation. When viewing this spectacle, it is easy to forget that all of this is the result of the efforts, the fortitude, and the genius of a relatively small group of men. Maurice Holland calls them the "Architects of Aviation."

In these days, when governments seem to have forgotten that men exist as individuals, when ambition and initiative seem to be going out of style, it is a refreshing and a good experience to read a book like this one which, in its two-hundred-odd pages, chronicles the achievements of a handful of Americans who were not afraid to think and to act on their own initiative.

Mr. Holland's new book is not only fascinating and inspiring, it is also a good source book for those interested in aviation lore. In it are fifteen excellent, photographic pages, showing the aviation pioneers, their products, and the results of their research. The book deals

[1] Chief engineer and chief instructor, Test Pilot Training Division, Naval Air Test Center, U. S. Naval Air Station, Patuxent River, Md. Visiting professor, University of Maryland, College Park, Md.

with those Americans who contributed fundamentally to aeronautics, Americans who, though their names are not too well known outside of aviation circles, were the ones who laid the real foundations of our aircraft industry as it exists today. After reading through the book, one is struck by the fact that certain well-known individuals (well-known to the general public, that is) are made conspicuous by the fact that they are hardly mentioned. This is the result of design—not accident, these latter people received publicity mainly because of the stunts they performed rather than for what they did to advance aviation.

In reviewing the book, only one statement made seemed questionable; that is the statement describing Alexander Klemin as short and stocky. Actually, he was of more than average height, although his broad build made him seem shorter. All in all, though, the reviewer was particularly pleased with the excellent account of Alexander Klemin's exploits. It seems regrettable that the book was not published prior to his death in the spring of 1950. He would have enjoyed it too.

This reviewer would not want to spoil the reader's pleasure by discussing more of the details of the book. Rather he would recommend it as must reading for anyone interested in aviation.

Books Received in Library

ADVANCED STRENGTH OF MATERIALS. By D. A. R. Clark. Blackie & Son Ltd., London, England, and Glasgow, Scotland, 1951. Linen, 6 × 8³/₄ in., 342 pp., diagrams, charts, tables, 35s. An advanced text to follow the author's previous "Materials and Structures," this book covers direct stress and strain and specialized stress situations in various structural members such as beams, struts, plates, etc. Separate chapters are devoted to thick cylinders subjected to fluid pressure and to the vibrations and whirling of shafts.

ASM REVIEW OF METAL LITERATURE, volume 7, 1950. Edited by M. R. Hyslop. American Society for Metals, Cleveland, Ohio, 1951. Cloth, 6 × 9¹/₄ in., 818 pp., $15. This is the seventh volume in a series which annually cumulates the installments published monthly in *Metals Review*. It represents a complete survey of the metallurgical literature published during the period January through December, 1950. The present volume contains a new method of classifying the annotations into subject subdivisions. In addition to a detailed table of contents, there are an extensive subject index and an author index.

ASTM BOOK OF STANDARDS, 1950 Supplements including Tentatives. American Society for Testing Materials, Philadelphia, Pa., 1950-1951. Paper, 6 × 9 in., illus., diagrams, charts, tables, $21.00 for complete set; $3.50 each. These 1950 Supplements give in their latest approved form some 353 specifications, tests, and definitions, which were either issued for the first time in 1950 or revised since the 1949 book. In six parts: Part 1 (316 pages), includes ferrous metals; Part 2 (223 pages), nonferrous metals; Part 3 (350 pages), cement, concrete, ceramics, thermal insulation, road materials, waterproofing, and soils; Part 4 (340 pages), paint, naval stores, wood, adhesives, paper, and shipping containers; Part 5 (579 pages), textiles, soap, fuels, petroleum, aromatic hydrocarbons, antifreezes, and water; and Part 6 (284 pages), electrical insulation, plastics, and rubber. All subjects usually dealt with are covered except chemical analysis of metals.

ASTM STANDARDS ON RUBBER PRODUCTS (with Related Information), prepared by ASTM Committee D-11, Methods of Testing, Specifications, May, 1951. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 640 pp., illus., diagrams, charts, tables, $5. Of interest to both producers and consumers of rubber products, this special compilation includes 100 standard and tentative test methods and specifications on rubber and rubberlike materials. Among the tests covered are processibility tests, physical and chemical tests of vulcanized rubber, aging and weathering tests, low-temperature and electrical tests. Specifications are given for such items as automotive and aeronautical rubber, hose and belting, tape, and electrical protective equipment. Emergency alternate provisions to the specifications are included.

ASTM, PROCEEDINGS, volume 50, 1950. ASTM, Philadelphia, Pa., 1951. Cloth, 6¹/₄ × 9¹/₄ in., 1490 pp., illus., diagrams, charts, tables, $12. This annual publication includes all reports and papers offered to and accepted by the Society's Committee on Papers and Publications. Both the Committee reports and the technical papers are arranged in broadly classified groups. The subject and author indexes cover not only the contents of the Proceedings but also the articles published in the ASTM Bulletin or as Special Technical Publications.

ASTM STANDARDS ON GASEOUS FUELS, prepared by ASTM Committee D-3, April, 1951. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 138 pp., illus., diagrams, charts, tables, $1.75. This publication is a compilation of the latest ASTM methods of tests pertaining to gaseous fuels. It contains a method of sampling natural gas and one on the measurement of gaseous-fuel samples. There are two methods of analyzing natural gases, one by the volumetric-chemical method and the other by the mass spectrometer. Three methods of testing the water-vapor content, the calorific value, and the specific gravity of gaseous fuels are given.

ACTES DU COLLOQUE INTERNATIONAL DE MÉCANIQUE, Poitiers, 1950. Volume I. Allocutions Études sur Descartes; Mécanique Thermique. Publications Scientifiques et Techniques du Ministère de l'Air, No. 248. En Vente au Service de Documentation et d'Information Technique de l'Aéronautique, Paris, France, 1951. Paper, 7 × 10¹/₂ in., 298 pp., illus., diagrams, charts, tables, 1800 fr. The papers contained in this report of an international conference on mechanics are arranged in two groups: a group of brief essays on the work of Descartes; and a larger group of technical studies. The latter deal with problems in the field of propulsion energy (supersonics, turbulence, shock waves, etc.), with modern questions on thermodynamics both theoretical and practical, and with various aspects of heat transfer.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

AIR SYSTEMS FOR AIRCRAFT. By C. A. H. Pollitt. Sir Isaac Pitman & Sons, Ltd., London, England, Pitman Publishing Corporation, New York, N. Y., 1950. Linen, 5¹/₂ × 8³/₄ in., 176 pp., diagrams, charts, tables, $4.75. For students of aircraft engineering and design, this book describes the construction and operation of the various pneumatic operating systems used in civil and military aircraft. It deals with the hymatic compressed-air system and equipment, the Dunlop pneumatic-brake system, superchargers, and other engine controls, air-conditioning and cabin-heating systems, and, in the case of military aircraft, with pneumatic gun-firing mechanisms and pneumatically operated bomb doors.

COMPANY PROCEDURAL MANUAL ON EQUIPMENT ANALYSIS. Published by William Kelly & Company, Chicago, Ill., 1951. Fabrikoid, 8¹/₂ × 11¹/₄ in., 45 pp., charts, $5. This manual provides basic instructions on a procedure for determining the economic advantage of new equipment, re-equipment, or replacement, and plant expansion. This practical publication by a management-counseling firm is based on researches of the Machinery and Allied Products Institute and is supplementary to two more extensive publications of the Institute which discuss equipment policy and analysis.

DESIGN OF MACHINE MEMBERS. By A. Vallance and V. L. Doughtie. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Linen, 6 × 9¹/₄ in., 500 pp., illus., diagrams, charts, tables, $6. This text has been prepared for the use of students who have had some training in kinematics, mechanics, and factory processes. Upon these as a foundation, the authors develop the theory involved in the design of the elements of operating machines and points out the variations from theory required by practical applications. Changes in this third edition include new material on stresses, riveted joints, threaded fasteners, power screws, gears, and hoisting and power chains. There are expanded treatments of endurance limit, eccentric loading, columns, and structural riveting.

DRUCKSCHWANKUNGEN IN EINER ZENTRIFUGALPUMPE UND DIE RECHNERISCHE BESTIMMUNG DER PUMPENCHARAKTERISTIKEN. By M. I. I. Rashed. Zurich, Switzerland, Eidgenössische Technische Hochschule, Institut für Hydraulik und Hydraulische Maschinen, Mitteilungen No. 3. Verlag Leemann, Zurich, 1951. Paper, 6³/₄ × 9¹/₂ in., 58 pp. plus 48 pp., illus., diagrams, charts, tables, 10.50 Swiss Fr. Based on studies made at the Institute for Hydraulics and Hydraulic Machinery at Zurich, this book provides a

detailed theoretical treatment of pressure changes in centrifugal pumps as well as experimental data. The effects of the number of impeller vanes on the speed and pressures of centrifugal pumps are discussed, a graphical method for the determination of pressure and speed distribution in the turbine wheel is given, and a description of an experimental pump together with data and the measuring procedures used is included.

Engineering Metallurgy. By A. P. Gwiazdowski. C. C. Nelson Publishing Co., Appleton, Wis., 1950. Cloth, 6 × 9¹/₄ in., 247 pp., illus., diagrams, charts, tables, $4. This text is designed to give the student, purchasing agent, production executive, and engineer basic metallurgical information about the nature and characteristics of the commercially important metallic elements and their alloys. Although information on nonferrous metals is included, the chief attention is given to ferrous metals. The objectives of the book are to present concise and clear definitions and principles, to provide information on the selection of materials and heat-treatments, and to consider engineering specifications. Review questions and references are grouped at the end of the book.

Hydraulic Transients. (Engineering Societies Monographs Series.) By G. R. Rich. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × 9¹/₄ in., 260 pp., diagrams, charts, tables, $6. Written for design engineers in the hydraulic and hydroelectric fields, this book applies arithmetic integration and trial-and-error arithmetic to the solution of a wide variety of problems in hydraulic transients. It not only furnishes a background for the arithmetic calculation of particular problems, but also provides the essential mathematical foundation for the supporting theory. Important features are the integration tabulations and detailed analysis of surge tanks, and the numerical designs which can be assimilated and imitated in commercial practice.

Internal-Combustion Engines. By L. C. Lichty. Sixth edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × 9¹/₄ in., 598 pp., illus., diagrams, charts, tables, $7. The sixth edition of this standard work is greatly revised, simplified, and enlarged to include material of current interest. Important changes are the addition of the Lenoir and Brayton cycles used in jets, turbines, and rockets, an amplified treatment of throttling and supercharging, an analysis of back pressure with exhaust-gas turbines, development of the analysis of jet thrusts from exhaust stacks of jet devices, and considerable new material on fuels, mixture formation, icing, preflame reactions, combustion knock, preignition, turbulence, combustion-chamber design, and fitting a fuel-injection system to a given combustion chamber. New charts, illustrations, and exercises are included.

Introduction to Heat Transfer. By A. I. Brown and S. M. Marco. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × 9¹/₄ in., 267 pp., diagrams, charts, tables, $4.50. Emphasizing basic principles and mathematical calculations, this book presents the essential fundamentals of the transmission of heat. Changes in this second edition include revision of the material on estimating heat conduction by the mapping method, new material on the characteristics of insulating materials and the calculation of solar radiation, expansion of the material on fluid flow, revised nomenclature, a new table of conversion factors, and a revision of graphs of physical properties of liquids and gases. The number of problems for student solution is more than doubled.

Introduction to the Theory of Control in Mechanical Engineering. By R. H. Macmillan. Cambridge University Press, American Branch, New York, N. Y.; also London and Cambridge, England, 1951. Cloth, 7¹/₄ × 10³/₄ in., 195 pp., diagrams, charts, tables, $6. This book explains the principles that underlie the action of automatic controls, servomechanisms, and regulators. The early chapters explain the principles of operation of all control systems; sufficient mathematics is then introduced to estimate the performance of any simple systems. In the last three chapters more advanced techniques are used to describe the methods used by control engineers. Linear differential equations are used in the first five chapters, and the theory of complex numbers and Laplace transformations are introduced before being used. A bibliography is included.

Linear Computations. By P. S. Dwyer. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1951. Cloth, 6 × 9¹/₄ in., 344 pp., tables, $6. This book is written for those who have the general problem of finding numerical solutions for sets of simultaneous linear equations. It first describes the theorems and methods in terms of elementary algebra and then develops the subject by including introductory material on determinants and on matrices. More powerful expositions are included in the later chapter. Many illustrative problems aid in translating the mathematical results to concise calculation methods. Special emphasis is given to the general subject of the accumulation of errors when the computations involve approximate numbers. Reference lists follow each chapter.

Lubrication, Its Principles and Practice. By A. G. M. Michell. Blackie & Son Ltd., London, England, and Glasgow, Scotland, 1950. Cloth, 7 × 10 in., 317 pp., illus., diagrams, charts, tables, 35s. This book not only provides a general account of the subject, but also includes essential data and factual information needed in daily practice. Following a consideration of physical properties and numerical constants of lubricants, the lubrication of sliding, thrust, journal, and rolling bearings, and various other mechanisms is discussed. The distribution and treatment of lubricants in service are also considered. A list of references is included.

Machinability and Machining of Metals. By N. E. Woldman and R. C. Gibbons. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × 9¹/₄ in., 518 pp., illus., diagrams, charts, tables, $7.50. This book sets forth the general principles of metal machining, the metallurgical characteristics of the materials as they relate to various mechanical and thermal treatments, and the types and compositions of cutting tools to be used. The approach is both theoretical and practical. Separate chapters deal with low-carbon steels, high-carbon steels, alloy steels, tool-and-die steels, stainless steels, and cast irons, as well as aluminum, magnesium, copper, nickel, and zinc-base alloys. One chapter is devoted to nonmetallic materials and another to cutting fluids. Much valuable information is given in the form of tables and graphs in the appendix.

Mathematical Solution of Engineering Problems. By J. Jennings. E.&F.N. Spon, Ltd., London, England, 1951. Cloth, 5³/₄ × 9 in., 208 pp., diagrams, charts, tables, 25s. This book has been particularly designed and written for the use of technicians who are familiar with basic mathematics but require guidance in effective practical application. Special features are the chapters on the construction of the nomogram, on statistical methods, and on dimensional analysis. The importance and utility of approximate methods of solution have been emphasized and practical illustrations given.

Messung der Oberflächengüte. By G. Schlesinger. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1951. Fabrikoid, 6 × 9¹/₂ in., 248 pp., illus., diagrams, charts, tables, 31.50 Dm. This book is concerned with the practical applications of results obtained from measurements of surface quality. In the initial section the nature and terminology of surface finish are defined. In subsequent sections the various measuring instruments for macro and micro-determination are discussed and the respective ranges of their applications. Finally, the results are given of industrial applications in the aircraft, automotive, railroad, tool, electrical machinery, and other industries. The effects of various surface-finishing procedures on surface roughness are also considered.

Molesworth's Handbook of Engineering Formulae and Data. Thirty-fourth edition. Edited by A. P. Thurston. E.&F.N. Spon, Ltd., London, England, 1951. Cloth, 4 × 6¹/₂ in., 1672 pp., diagrams, charts, tables, $6.50. This comprehensive compilation of engineering information, formulas, and data has been completely revised, rewritten, and expanded to conform to the current requirements of the engineering profession. Section 1 (665 pages) covering the fundamentals of mathematics, mechanics, materials, physical data, etc., is followed by Sections 2, civil and general engineering (540 pages), 3, mechanical engineering (330 pages), and 4, electrical engineering (100 pages). A 50-page index provides effective access to the contained information.

Monte Carlo Method. (Applied Mathematics Series No. 12.) U. S. Bureau of Standards, Washington, D. C., 1951. Paper, 8 × 10¹/₄ in., 42 pp., charts, tables, paper, $0.30, for sale by Government Printing Office, Washington 25, D. C. Thirteen papers and discussion are presented from the Symposium on the Monte Carlo Method, an interesting combination of sampling theory and numerical analysis. The method is a device for studying an artificial stochastic model of a physical or mathematical process, such as the random motions encountered in the field of statistical mechanics. The papers in this volume deal with current applications of the method and with random digits.

Nomographic Charts. By C. A. Kulmann. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 7¹/₄ × 10¹/₄ in., 244 pp., diagrams, charts, tables, $6.50. Ninety-two nomographs are given for solving a variety of functional and general problems in such fields as hydraulics, mechanics, thermodynamics, and electrical engineering. Each chart occupies a full page and is accompanied by an explanation to aid in its use. The accuracy of the charts lies between ordinary slide-rule computation and exact numerical computation. Alignment, intersection, and combinations of intersection and alignment nomographs are the types given.

Performance of a Piston-Type Aero-Engine. By A. W. Morley. Sir Isaac Pitman & Sons, Ltd., London, England, 1951. Linen, $5^1/_2 \times 8^3/_4$ in., 143 pp., charts, diagrams, tables, 25s. Of interest to those engaged in the design of aircraft and aircraft power units, this small volume gives an account of the author's research into the behavior of the piston-type engine under varying conditions of flight. The first part deals with aero-engine altitude laws and their particular application to a Merlin engine. The remainder considers the combination of a piston unit and exhaust-gas turbine.

Petroleum Facts and Figures. Ninth edition. American Petroleum Institute, New York, N. Y., 1951. Paper, 6×9 in., 491 pp., illus., tables, \$2.50. This reference work provides facts and figures on the petroleum industry for oilmen, students, educators, journalists, economists, and all others who have an interest in the subject. It is divided into sections devoted to utilization, production, refining, transportation, marketing, prices and taxation, and other topics. There are individual indexes for each section and a classified cross index.

Physical Chemistry of Lubricating Oils. By A. Bondi. Reinhold Publishing Corporation, New York, N. Y., 1951. Cloth, $6 \times 9^1/_4$ in., 380 pp., illus., diagrams, charts, tables, \$10. Of interest to all concerned with problems in lubricant technology, this book provides the latest theories on lubricating oils and the physical and chemical principles underlying their action. Separate chapters deal with pressure-volume-temperature properties, viscosity, surface phenomena, optical and electrical properties, phase equilibria, and reaction kinetics. The hydrocarbon-type analysis of lubricating oils is discussed as well as the properties of synthetic lubricants. Bibliographies are placed at the ends of the chapters.

Principles of Industrial Management. By L. P. Alford, revised and rewritten by H. R. Beatty. Ronald Press Co., New York, N. Y., 1951. Linen, $6 \times 9^1/_4$ in., 779 pp., illus., diagrams, charts, tables, \$6. Completely rewritten and thoroughly modernized, this book presents the basic principles and methods used in the management of an industrial enterprise. Changes in this second edition include a new chapter on industrial leadership, a revised section on personnel administration, a new chapter on marketing the product, and expansion of the chapters on quality control and time and motion study to include the newer techniques. Questions for review, problems, and a selective bibliography follow each chapter.

Problems for the Numerical Analysis of the Future. (Applied Mathematics Series No. 15.) U. S. Bureau of Standards, Washington, D. C., 1951. Paper, $8 \times 10^1/_4$ in., 21 pp., diagrams, charts, \$0.20, for sale by Government Printing Office, Washington 25, D. C. This publication contains four papers which were presented at the 1948 Symposia on Modern Calculating Machinery and Numerical Methods. They deal with various aspects of numerical analysis in nonlinear mechanics, wave propagation, etc.

SAE Handbook 1951. Society of Automotive Engineers, New York, N. Y., 1951. Cloth, $8^1/_2 \times 11^1/_4$ in., 864 pp., illus., diagrams, charts, tables, \$10. Completely revised and restyled, the 1951 Handbook contains technical reports, standards, and recommended practices for the automotive industry. It covers materials, parts, and equipment for all kinds of motor vehicles. Separate sections deal with ferrous, nonferrous and nonmetallic materials, common parts, engines and electrical equipment, and equipment for passenger cars, trucks, buses, tractors, earthmoving, and marine use.

Schmierung von Dampfturbinen. By K. Wolf. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1951. Paper, 6×9 in., 198 pp., illus., diagrams, charts, tables, 16.50 Dm. Covering all aspects of the lubrication of steam engines, this book discusses the following topics in detail: the characteristics of the lubricants; the construction of lubricating and regulating systems; the characteristics, causes, and prevention of abnormal lubricating conditions; lubricating specifications; evaluation of service-life of lubricants; control and protective maintenance; and economic considerations.

Some Aspects of Fluid Flow, being the papers presented at a Conference organized by The Institute of Physics at Leamington Spa, October 25–28, 1950, and the Reports of the Conference Discussion Groups. Longmans, Green and Co., New York, N. Y.; Edward Arnold & Co., London, England, 1951. Cloth, 6×9 in., 292 pp., illus., diagrams, charts, tables, \$9.50; 50s. Presents in summarized form the papers and reports from discussion groups given at a 1950 conference. The papers are grouped under the following subject headings: industrial problems, fundamental problems in aerodynamics and hydrodynamics, techniques for the study and measurement of fluid flow, and applications of present knowledge and techniques. References are given at the end of most of the papers, and a subject index is included.

Structure and Mechanical Properties of Metals. (Monographs on Metallic Materials of the Royal Aeronautical Society, vol. 2.) By B. Chalmers. John Wiley & Sons, Inc., New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 132 pp., illus., diagrams, charts, tables, \$3.50. This book provides the simplest possible picture of the structure of metals and alloys and its relation to the mechanical properties. The structure of a pure metal is first discussed, followed by a consideration of the effects of alloying elements on the structure. The process of mechanical deformation is described, and the effects of both mechanical deformation and heat-treatment on structure are considered. A brief and general account is given of the ways in which the structure can be examined and determined. Finally, the more important mechanical properties and their dependence on structure are considered.

Mechanics Applied to Vibrations and Balancing. By D. L. Thornton. Second edition. Chapman & Hall, Ltd., London, England, 1951. Cloth, $6^1/_4 \times 10$ in., 584 pp., illus., diagrams, charts, tables, 50s. Written for engineers and physicists, this book presents the general theory of vibrations in its various aspects. This second edition contains a rewritten general survey and a new chapter dealing with the transmission of stress under conditions of rapidly applied loading, such as are encountered in the design of fortifications and structures to withstand the effects of explosions. Includes chapters on balancing of engines and locomotives, propagation of stress in elastic materials, beams and plates, rotating shafts and disks, and dynamic loading of structures.

Tables of $n!\ \Gamma(n + {}^1/_2)$ for the First Thousand Values of n. (Applied Mathematics Series No. 16.) U. S. Bureau of Standards, Washington, D. C., 1951. Paper, 8×10 in., 10 pp., tables, \$0.15, for sale by Government Printing Office, Washington 25, D. C. These tables give values for factorial n to 16 significant figures and for the accompanying function to eight significant figures. The values are tabulated in such a way as to facilitate their use by covering 100 integers per page.

Tables Relating to Mathieu Functions, prepared by the Computation Laboratory of the National Bureau of Standards. Published by Columbia University Press, New York, N. Y., 1951. Cloth, $8 \times 10^3/_4$ in., 278 pp., tables, charts, \$8. Tables given in this volume provide the following: characteristic values of Mathieu's differential equation; special coefficients; joining factors; and other specialized values of relevant nature. The introduction includes a general survey of the characteristics of the functions, methods of handling them, interpolations, and the methods used in computing the tables. Values in the tables are given to seven or more decimal places.

Technical Libraries, Their Organization and Management. Edited by L. Jackson. Special Libraries Association, New York, N. Y., 1951. Cloth, $6 \times 9^1/_4$ in., 202 pp., illus., diagrams, charts, tables, \$6. Of value to all organizations now maintaining a scientific or technical library, or contemplating starting one. Based on the experience of many librarians in many libraries, this book contains tested methods of operation and specific information on all phases of the subject. There are chapters on such items as staff, budget, physical layout, equipment documentation, reference procedures, and the selection, acquisition, classifying, and cataloging of books and periodicals.

Thermal Testing of Steam Boilers. By L. S. Brown. Sir Isaac Pitman & Sons, Ltd., London, England; Pitman Publishing Corporation, New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 149 pp., diagrams, charts, tables, \$4. Written for the boiler engineer engaged in industrial testing, this book translates the theory of boiler testing into practical examples and deals fully with the various types of boiler installations. It sets out the progressive steps for calculating the thermal gains and losses in steam boilers and the observations and data required to make such calculations. All the technical data needed to calculate efficiencies and steam costs are provided. The appendix contains numerous tables, graphs, formulas, and other valuable information.

Tool Engineering. By A. P. Gwiazdowski. C. C. Nelson Publishing Co., Appleton, Wis., 1951. Cloth, $6 \times 9^1/_4$ in., 306 pp., illus., diagrams, charts, tables, \$6. Following the beginning discussions of limits, tolerances, measuring, and gaging, the general procedure for tool design is given. Separate chapters are devoted to the standard major machine-shop processes, milling, drilling, etc., and special design factors are emphasized. Cutting fluids, tool steels, and the heat-treatment of ferrous alloys are also covered.

Viscosity and Plasticity. By E. N. da C. Andrade. Chemical Publishing Co., Inc., New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 82 pp., illus., diagrams, charts, tables, \$2.25. This volume contains three lectures given under the auspices of the London Section of the Oil and Colour Chemists' Association. The first deals with the nature and theories of liquid viscosity; the second with the flow of simple liquids, suspensions and gels; and the third with the flow of solids.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting July 27, 1951, and approved by the Board, September 26, 1951.)

CASE No. 897-3 (REOPENED)

(Special Ruling)

In the "Reply" under "Specifications," Par. (1) (a), add as a third paragraph:

The addition of columbium to Grade 8, Type 309, of Specification SA-167 is also permitted. The carbon content of this grade shall be limited to 0.08 per cent and the columbium content shall not be less than 10 times the carbon content nor more than 1.00 per cent. This grade of material shall be marked 309 Cb for identification.

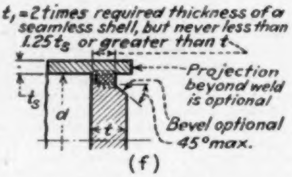
CASE No. 1132

(Special Ruling)

Inquiry: In view of the urgent need and published revisions for Figs. P-21(f), U-4(f), and UG-34(f), with the corresponding revisions for Pars. P-198(a), U-39(a) and UG-34 on the attachment of flat heads by welding, in the September, 1950, issue of MECHANICAL ENGINEERING, may these provisions now be used?

Reply: Since there have been no adverse criticisms of these proposed revisions, it is the opinion of the Committee that the following revisions of the sketches and paragraphs meet the intent of the Code and may now be used:

FIGS. P-21, U-4, AND UG-34. Substitute the following for sketch (f):



FIGS. P-21, U-4, AND UG-34. SKETCH (F)

PAR. P-198(a). Page 72, Power Boiler Code

Revise fifth definition for C to read:

C = 0.50 for plates fusion welded to the inside of a drum (or pipes and headers) as shown in Fig. P-21(f) and otherwise meeting the requirements for the respective types of fusion-welded boiler drums, including stress-relieving when required for the drum, but omitting radiographic examination, where the weld has a minimum throat dimension equal to two times the required thickness of a seamless shell, but not greater than the head thickness nor in any case less than 1.25 times the actual shell thickness, and where the weld is deposited in a welding groove with the root of the weld at the inner face of the head, as shown in Fig. P-21(f). Beveling of the remainder of the head plate to an angle not exceeding 45 degrees is optional.

PARS. U-39(a) Page 41, 1949 Unfired Pressure Vessel Code, and UG-34, Page 39, 1950 Unfired Pressure Vessel Code. Revise fifth definition for C to read:

C = 0.50 for plates fusion welded to the inside of a vessel (or pipes and headers) as shown in Figs. U-4(f) and UG-34(f) and otherwise meeting the requirements for the respective types of fusion-welded vessels, including stress-relieving when required for the vessel, but omitting radiographic examination, where the weld has a minimum throat dimension equal to two times the required thickness of a seamless shell, but not greater than the head thickness nor in any case less than 1.25 times the actual shell thickness, and where the weld is deposited in a welding groove with the root of the weld at the inner face of the head, as shown in Figs. U-4(f) and UG-34(f). Beveling of the remainder of the head plate to an angle not exceeding 45 degrees is optional.

CASE No. 1135

(Special Ruling)

Inquiry: May vessels for service at temperatures below —20 F under the requirements of Pars. U-140 to U-142 be constructed in part or whole of nickel steel castings complying with Specification SA-217, with the exception of chemistry which shall be as follows:

Carbon, max. per cent	0.15
Manganese, per cent	0.40 to 0.80
Phosphorus, max. per cent	0.05
Sulphur, max. per cent	0.06
Silicon, max. per cent	0.60
Nickel, per cent	3.00 to 4.00

and with mechanical properties as follows:

Tensile str., min. psi	65,000
Yield point, min. psi	40,000
Elongation in 2 in., min. per cent	24
Reduction in area, min. per cent	35

Reply: It is the opinion of the Committee that such castings will meet the intent of the Code for low-temperature service. Design stresses up to a temperature of 650 F may be taken, the same as for Grade WC-2 of SA-217.

The castings shall be in the normalized and drawn condition.

CASE No. 1139

(Special Ruling)

Inquiry: May various types of alloy steel bolting covered by SA-193, Grades BA, BB, and BC, be used under the ASME Boiler Construction Code for all sections?

Reply: It is the opinion of the Committee that pending revision of the Code to correct the editorial omission of SA-193, Grades BA, BB, and BC, from Table UG-23, 1950 edition, and Table U-2, 1949 edition, these grades may be used with stresses as tabulated below.

	For metal temp not exceeding deg F		
Grade	—20 to 650	700	750
BA	16250	14950	13650
BB	18750	17200	15650
BC	20000	18400	16750

When using these stresses for design under the 1949 edition, the values of S_a and S_b shall not be increased by the multiplier 1.25 as permitted in Table UA-9 (1949 edition)

CASE No. 1140

(Special Ruling)

Inquiry: In view of the fact that no more revisions to the 1949 edition of Sec-

tion VIII are to be made, except indirectly by the issuance of Cases, may revisions to paragraphs of revised Section VIII (1950 edition, additions thereto, and subsequent editions) relating to types of construction and materials, be applied to paragraphs of the same intent in the 1949 edition?

Reply: It is the opinion of the Committee that when revised Section VIII (1950 edition, additions, thereto, and subsequent editions) and the 1949 edition of Section VIII contain paragraphs of the same intent (but not necessarily of the same wording) relating to types of construction and materials, a revision to a paragraph of revised Section VIII (1950 edition, additions thereto, and subsequent editions) constitutes a revision of the corresponding paragraph of the 1949 edition and may be so used.

CASE No. 1141

(Special Ruling)

Inquiry: May steel produced to an SA specification in a foreign country be used in the construction of ASME Code boilers or pressure vessels?

Reply: It is the opinion of the Committee that an ASTM specification does not restrict the location of the steel mill producing the material. So long as all specification requirements are met as indicated by a certified mill test report and the evidence is satisfactory to the authorized inspector that the steel was produced by an established and reputable steel mill to such specification, such steel may be used.

If there is any doubt regarding the data presented, the authorized inspector may call for check tests as provided for in the specification.

Material that can not be properly identified may be qualified under Case No. 1025 for plates and Case No. 1067 for pipe and tubes, for boilers. For pressure vessels, provisions are incorporated in Section VIII for such identification.

CASE No. 1144

(Interpretation of Par. P-23(a))

Inquiry: May the revision to Par. P-23(a) as published in the August, 1951, issue of MECHANICAL ENGINEERING be used?

Reply: It is the opinion of the Committee that the construction under the proposed addition to Par. P-23(a) given below will meet the intent of the Code:

For boilers installed on the unit system (i.e. one boiler and one turbine or other prime mover) and provided with automatic combustion control equipment responsive to steam header pressure, the value of P for the steam piping shall be not less than the design throttle pressure plus 5 per cent, or not less than 85 per cent of the lowest pressure at which any drum safety valve is set to blow, whichever is greater, and the *S* value for the material used shall not exceed that permitted for the expected steam temperature at the superheater outlet.

Cases Annulled

The following includes recapitulation of all cases annulled since publication of the latest revision of ASME Boiler Code Interpretations, January 1, 1950.

Case Nos.	Based on Revision of Pars.
824	*
935	Case No. 1074
985	P-299, UA-19 and UA-46
1017	*
1026	*
1046	UW-28
1050	P-186(f) and Appendix A-73
1051	*
1059	P-311(b)
1061	*
1065	*
1067	UG-6(d) and UG-9
1070	P-180(d), P-22
1072	Table P-7 and Spec. SA-315
1079	H-40
1080	SA-299(e), Table Q-5
1084	P-257(b)
1085	*
1086	*
1089	P-318
1099	Section I, Appendix A-20(b)
1101	P-242
1102	P-301
1103	Table P-7
1104	UW-13
1105	P-112(c)
1112	P-186(c)

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

TABLES P-5 & P-7. Add to the allowable stress values given in Appendix 2 to "Revisions" in the August, 1951, issue of MECHANICAL ENGINEERING, page 676, those given herewith in Appendix A.

In the Austenitic Alloys section add a column for specifications and insert the following groups:

As applying to the first two lines (for 18 Cr 8 Ni material)—SA-213 Tp 304, SA-240 Gr. S, SA-158 P8a and SA-182 F-8.

As applying to the third line (for 18 Cr 8 Ni Cb material)—SA-213 Tp 347, SA-240 Gr. C, SA-158 P8d, and SA-182 F8c.

As applying to the fourth line (for 18 Cr 8 Ni Ti material)—SA-213 Tp 321, SA-240 Gr. T, SA-158 P8b, and SA-182 F8t.

As applying to the fifth and last line (for 16 Cr. 13 Ni 3 Mo material)—SA-213 Tp 316, SA-240 Gr. M, and SA-182 F8m.

Unfired Pressure Vessels 1950

TABLE UG-23. Make the following revisions and additions to Table UG-23 as printed in MECHANICAL ENGINEERING, September, 1951, pages 760 and 761:

Under Plate Steels (Carbon Steels): Change "ASTM-A-7-50T" to "SA-7." On the same line, under —20 to 650, change "13800" to "12650." On the line for SA-30 Flange, delete "(2)" under Notes. Change "ASTM-A-113-50T" to "SA-113." Change "ASTM-A-283-50T" to "SA-283" for grades A, B, C, and D. On the line for grade D under —20 to 650 change "13800" to "12650."

Under Plate Steels (Low Alloy Steels): Change "SA-294" to "SA-204" for grade A.

Under Pipes and Tubes (Seamless Low Alloy Steels): Opposite SA-158 grade P5b, under 1100, change "2800" to "2500." Opposite SA-158 P5c, under 1100, change "4000" to "2800." Opposite SA-209 T1a, under 850, change "13150" to "13750."

Under Forgings (Carbon Steels): Opposite SA-105 I, under 750, change "12590" to "12950."

Under Forgings (Low Alloy Steels): Revise or add the three lines for SA-182 in Appendix B.

Under Castings (Carbon Steels): Opposite SA-216 WCA, under 800, change "19800" to "10800."

Under Castings (Low Alloy Steels): Opposite SA-217 C5 and SA-217 C12, under —20 to 650, change "21600" and "22000," both to "22500."

* Occasion of annulment obsolescence not attributable to specific revisions.

APPENDIX A—ADDITIONAL ALLOWABLE STRESS VALUES FOR TABLES P-5 AND P-7

Material & Specification No.	Grade	Spec. Min Tensile	—20 to 650	700	750	800	850	900	950	1000
			For metal temperatures not exceeding deg F							
PLATE STEELS										
Low Alloy Steels										
SA-203	A & D	65000	16250	15500	13850	11400	7800	5000	3000	1500
	B & E	70000	17500	16600	14750	12000	7800	5000	3000	1500
	C	75000	18750	17700	15650	12000	7800	5000	3000	1500
SA-225	A	70000	17500	16600	14750	12000	7800	5000	3000	1500
	B	75000	18750	17700	15650	12000	7800	5000	3000	1500
FORGINGS										
Carbon Steel										
SA-105	I	60000	15000	14350	12950	10800	7800	5000	3000	
	II	70000	17500	16600	14750	12000	7800	5000	3000	
SA-181	I	60000	15000	14350	12950	10800	7800	5000	3000	
	II	70000	17500	16600	14750	12000	7800	5000	3000	
SA-266	1	60000	15000	14350	12950	10800	7800	5000	3000	
	2	70000	17500	16600	14750	12000	7800	5000	3000	
	3	75000	18750	17700	15650	12000	7800	5000	3000	

Material & Specification No.	Grade	Type	Spec. Min Tensile	—20 to 400	500	600	650	700	750	800	850
FORGINGS											
Low Alloy Steels											
SA-182	F-1	C-Mo	70,000	17500	17500	17500	17500	17500	17500	16900	15000
	F-2	1% Cr 5 Mo	70,000	17500	17500	17500	16800	16150	15500	14850	14200
	F-5	5 Cr 5 Mo	90,000	22500	21600	20100	19000	17500	16000	14500	13000
	F-17	9 Cr 1 Mo	100,000	25000	24000	22700	22000	21200	20000	17700	15400
	F-22	$2^1/_4$ Cr 1 Mo	70,000	17500	17500	17500	17500	17500	17500	17500	16000

900	950	1000	1050	1100	1150	1200	Material & Specification No.	
12750	8500	5500					SA-182	F-1
13100	11000	7500	5000	2800				F-2
11500	10000	7300	5200	3300	2200	1500		F-5
13100	10800	8500	5500	3300	2200	1500		F-17
14000	11000	7800	5800	4200	3000	2000		F-22

APPENDIX B—REVISIONS AND ADDITIONS TO TABLE UG-23

Material and Specification No.	Grade	Spec. Min Tensile	Notes	—20 to 650	700	750	800	850	900	950	1000	1050	1100	1150	120
				For metal temperatures not exceeding deg F											
FORGINGS															
Low Alloy Steels															
SA-182	F-2	70000	(15)	...	16150	15500	14850	14200	13100	11000	7500	5000	2800	1550	1000
SA-182	($1^1/_4$ Cr-$^1/_2$ Mo)	70000	(15)	...	16150	15500	15000	14400	13100	11000	7800	5500	4000	2500	1200
SA-182	F-17	100000	(15)	...	21200	20000	17700	15400	13100	10800	8500	5500	3300	2200	1500
BARS															
Carbon Steels															
SA-306	50	50000	...	12500	...	...	...	...	...	...	...	...	...	...	...
SA-306	55	55000	...	13750	...	...	...	...	...	...	...	...	...	...	...
SA-306	60	60000	...	15000	...	...	...	...	...	...	...	...	...	...	...

APPENDIX C—TABLE UG-27 MAXIMUM ALLOWABLE STRESS VALUES IN TENSION FOR CARBON AND LOW ALLOY PIPE AND TUBES OF WELDED MANUFACTURE, IN POUNDS PER SQUARE INCH

Joint efficiencies used for preparing this table are:
Electric-Resistance Welded—85%, Lap Welded—80%, Butt Welded—60%

Specification Number	Grade	Weld	Notes	Spec. Min Tensile	—20 to 650	700	750	800	850	900	950	1000
					For metal temperatures not exceeding deg F							
SA-53	Steel	Lap	(1)	45000	9000	8800	8200	...	...	...	...	...
SA-72	Wr. Iron	Lap		40000	8000	7800	7300	...	...	...	...	...
SA-72	Wr. Iron	Butt		40000	6000	5850	5500	...	...	...	...	...
SA-83	A (Steel)	Lap		(45000)	9000	8800	8200	...	...	...	...	...
SA-83	B (Wr. Iron)	Lap		(40000)	8000	7800	7300	...	...	...	...	...
SA-135	A	Resis.	(2)(3)	48000	10200	9900	9100	7900	6700	5500	3800	2150
SA-135	B	Resis.	(2)(3)	60000	12750	12100	11000	9200	7350	5500	3800	2150
SA-178	A	Resis.	(2)(3)	(47000)	10000	9700	8950	7800	6650	5500	3800	2150
SA-178	B	Resis.		(40000)	8500	8300	7750	...	...	...	...	...
SA-178	C	Resis.	(2)(3)	60000	12750	12200	11000	9200	7350	5500	3800	2150
SA-226		Resis.	(2)(3)	(47000)	10000	9700	8950	7800	6650	5500	3800	2150
SA-250	Tl	Resis.		55000	11700	11700	11700	11450	11200	10650	8500	5300
SA-250	Tla	Resis.		60000	12750	12750	12750	12250	11700	10650	8500	5300
SA-250	Tlb	Resis.		53000	11250	11250	11250	11050	10800	10650	8500	5300

Notes: (1) These stress values permitted for open-hearth and electric-furnace steels only.
(2) For service temperatures above 850 F it is recommended that killed steels containing not less than 0.10% residual silicon be used. Killed steels which have been deoxidized with large amounts of aluminum and rimmed steels may have creep and stress-rupture properties in the temperature range above 850 F, which are somewhat less than those on which the values in the above table are based.
(3) Only (silicon) killed steel shall be used above 900 F.

Under Bolting (Carbon Steels): Opposite SA-261 BO, under 850, change "6875" to "6900."

For Bars (Carbon Steels): Add the three lines for SA-306 as shown in Appendix B.

Note (11) Add "specified" before "tensile strength" and "yield strength."

Note (15) Add the following materials:

Spec.	Grade	−20 to 400	500	600	650
SA-182	(1¼ Cr.-½ Mo.)	17500	17500	17500	16800
SA-182	F17	25000	24000	22700	22000

TABLE UG-27. Delete entire table and substitute Appendix C.

TABLE UHA-23. Make the following revisions and additions to left half of Table UHA-23 as printed in MECHANICAL ENGINEERING, September, 1951, page 762:

Under Plate Steels: Opposite the two lines for SA-167 grade 3, under Notes, delete "(2)." Opposite the two lines for SA-167 grade 10, under Notes, change the "(3)" to "(2)" and "(4)" to "(3)." Opposite SA-167 grade 11, under Notes, delete "(2)." Insert the two lines for SA-240, grades B and O, from Appendix D. Opposite the three lines for SA-240 grades M and S, under Notes, delete "(2)."

Under Pipes and Tubes (Seamless): Opposite the two lines for SA-158 P8a, under Notes, delete "(2)." Opposite the two lines for SA-213 TP 304, under Notes, delete "(2)." Opposite SA-213 TP 316, under Notes, delete "(2)." Opposite the two lines for SA-213 TP 310, under Notes, change "(3)" to "(2)" and "(4)" to "(3)."

Under Pipes and Tubes (Welded): Opposite the two lines for SA-249 TP 304, under Notes, delete "(2)" and change "(5)" to "(4)." Insert the two lines for SA-249 TP 310 from Appendix D.

Opposite SA-249 TP 321 and SA-249 TP 347, under Notes, change "(5)" to "(4)."

Opposite SA-249 TP 316, under Notes, delete "(2)" and change "(5)" to "(4)."

Opposite SA-249 TP 317, under Notes, change "(5)" to "(4)."

Under Pipes and Tubes (Forgings): Opposite the two lines for SA-182 F8, under Notes, delete "(2)." Opposite SA-182 F8m, under Notes, delete "(2)." Opposite SA-182 F25, under 300, change "27750" to "23750."

Under Pipes and Tubes: Insert as a new subhead "Castings" and follow with the three lines for SA-157 from Appendix D.

Under Pipes and Tubes (Bolting): Substitute the three lines for SA-193 from Appendix D.

TABLE UHA-23. Make the following revisions to right half of Table UHA-23 as printed in MECHANICAL ENGINEERING, September, 1951, page 763:

Under Plate Steels: Opposite SA-167-11, under 1100, change "12400" to "10400." Insert the two lines for SA-240 B and O from Appendix D.

Under Pipes and Tubes (Welded): Insert the two lines for SA-249 TP 310 from Appendix D.

Under Pipes and Tubes: In Material and Specification column insert the subhead "Forgings" between specifications for SA-249 and SA-182. Opposite SA-182 F8t under 1300, change "3700" to "2700."

Under Pipes and Tubes: Insert as a new subhead "Castings" and follow with the three lines for SA-157 from Appendix D.

Under Pipes and Tubes (Bolting): Substitute the three lines for SA-193 from Appendix D.

Under Notes at bottom of table on both pages (762 and 763), delete Note "(2)" and change "(3)" to "(2)," "(4)" to "(3)," "(5)" to "(4)," and "(6)" to "(5)."

Announcement

Parts UCI (Cast Iron) and UB (Brazing) for Section VIII (Code for Unfired Pressure Vessels) 1950 have been approved as parts of this section.

Welding Qualifications 1949

TABLE Q-5 Under "P" Number 5—"O" Number 1. Add:

Spec. No.	Grade	Name
SA-213	WC9	Chrome-molybdenum alloy steel castings.

APPENDIX D—REVISIONS AND ADDITIONS TO TABLE UHA-23

(*Left Half*) as printed in MECHANICAL ENGINEERING, September, 1951, page 762

Material and Specification No.		Grade	Type	Spec. Min. Tensile	Notes	For metal temperatures not exceeding deg F: —20 to 100	200	300	400	500	600	650	700	750
PLATE STEELS														
	SA-240	B	...	70000	...	17500	17500	16300	15650	15100	14600	14300	13900	13500
	SA-240	O	405	60000	...	15000	15000	14700	14400	13950	13400	13000	12450	11800
PIPE & TUBES Welded														
	SA-249	TP310	...	75000	(2)	16000	16000	15750	15500	15050	14600	14400	14100	13800
	SA-249	TP310	...	75000	(3)	16000	16000	15750	15500	15050	14600	14400	14100	13800
CASTINGS														
	SA-157	C6	...	90000	...	22500	22500	22500	22500	22500	22000	21600	20700	19600
	SA-157	C9a	...	70000	(1)	17500	16500	15600	15000	14600	14350	14200	14050	13850
	SA-157	C9a	...	70000	...	17500	15700	14250	13100	12200	11700	11500	11300	11100
BOLTINGS														
	SA-193	B6	416	...	(5)	20000	19300	18700	18300	17850	17000	16400	15500	14000
	SA-193	B8	321 and 347	...	(5)	15000	15000	13600	12650	12200	11900	11850	11800	11750
	SA-193		304	...	(5)	15000	13300	12000	10900	10000	9300	8950	8650	8300

(*Right Half*) as printed in MECHANICAL ENGINEERING, September, 1951, page 763

For metal temperatures not excluding deg F: 800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	Material and Specification No.
															PLATE STEELS
13100	12500	11700	9200	6500	4500	3200	2400	1750	...	...	...	...	...	...	SA-240, B
11000	10100	9100	8000	4000	...	...	...	...	...	...	...	...	...	...	SA-240, O
															PIPES & TUBES Welded
13350	12700	11700	10600	9350	8300	7200	6150	5100	4050	3000	2000	1350	950	650	SA-249, TP310
13350	12700	11700	10600	9350	6000	4250	3050	2100	1250	650	400	300	200	150	SA-249, TP310
															CASTINGS
18300	16000	11000	7600	5000	3300	2200	1500	1000	...	...	...	...	...	...	SA-157, C6
13600	13350	13000	12600	12100	9600	7500	5750	4500	3250	2450	1800	1400	1000	750	SA-157, C9a
10900	10650	10400	10100	9850	9600	7500	5750	4500	3250	2450	1800	1400	1000	750	SA-157, C9a
															BOLTING
13000	11200	8800	...	...	...	...	...	...	...	...	...	...	...	...	SA-193, B6
11650	11450	11300	11100	10800	10500	10000	6400	4000	2900	2200	1600	1250	950	800	SA-193, B8
8000	7750	7500	7250	7050	6800	6000	4600	3600	2600	1950	1450	1100	800	600	SA-193, 304

THE ENGINEERING PROFESSION

News and Notes

ECPD Meets in Boston

Guidance and Training Featured at 19th Annual Meeting

GUIDANCE and Training were featured at the 19th annual meeting of the Engineers' Council for Professional Development held at the Hotel Statler, Boston, Mass., Oct. 19 and 20, 1951. A panel of guidance directors from the Boston area constituted the first of a series of similar sessions to be sponsored by the ECPD Guidance Committee in various parts of the country in connection with its recently formulated program. The Training Committee, which made a well-remembered presentation last year of its report "The First Five Years After Graduation," put on a panel to review the highlights of the six-point program that was outlined in the report. The Education Committee submitted a report on adequacy and standards of engineering education that deserves careful study and comment by educators and practicing engineers. Addresses by Harold B. Richmond and James R. Killian, Jr., at the luncheons, and by Eugene W. O'Brien, at the annual dinner, further emphasized the importance of guidance and training.

H. S. Rogers Re-Elected Chairman

At the administrative session of the Council, held on Friday morning, Harry S. Rogers, president, Polytechnic Institute of Brooklyn, was re-elected chairman, and Lieut. Col. L. F. Grant, field secretary, The Engineering Institute of Canada, was re-elected vice-chairman. Secretary for the year 1951–1952 will be E. H. Robie, secretary AIME, and the assistant secretary will be C. E. Davies, secretary ASME. The Executive Committee will be composed of the foregoing officers and V. T. Boughton (ASCE), C. E. Lawall (AIME), G. R. Cowing (ASME), M. D. Hoover (AIEE), W. J. W. Reid (EIC), H. T. Heald (ASEE), C. G. Kirkbride (AIChE), and C. S. Crouse (NCSBEE).

Representatives of ASME on ECPD are Guy R. Cowing, William F. Ryan, and A. C. Monteith. Chairman of ECPD Standing and Special Committees elected at the Boston meeting are: Guidance, B. G. A. Skrotski; Education, Thorndike Saville; Training, A. C. Monteith; Recognition, R. H. Barclay; Information, John Beall; Ethics, William F. Ryan; and Student Development, Walter J. Seeley.

ECPD Financial Statement

At the administrative session of the Council on Friday morning the financial statement for 1950–1951 and the report of the auditors were accepted. The financial statement showed a balance as of a year ago of $21,958.07, receipts during the year of $41,233.80, expenditures of $28,930.11, and a balance as of Sept. 30, 1951, of $34,261.76. The balance sheet showed reserves of $47,859.76 which includes the publications surplus (cash plus inventory) of $15,005 and monies received and earmarked for the Special Training Program of $8901. A budget for 1951–1952 was adopted.

1952 Meeting to be Held in Chicago

It was voted to hold the 20th annual meeting at the Hotel Sherman, Chicago, Ill., Sept. 11–12, 1952, in conjunction with the Centennial of the American Society of Civil Engineers.

Accreditation Activities

At a closed session of the Council the Education Committee rendered its report on accreditation of undergraduate engineering curricula and programs of technical-institute type in the United States. By action of the Council, 25 curricula and 16 technical-institute programs were added to the accredited lists. With the publication of the complete ECPD report for 1950–1951 these newly accredited curricula and programs will be made public.

Reports of ECPD Committees

The reports of the standing and special committees and of the representatives of the constituent societies were available at the Boston meeting in preprint form. The essence of these reports will be found in the report of the chairman of ECPD, Harry S. Rogers, which is printed in this issue of Mechanical Engineering under the title "Service, Motivation, and Support." Because Dr. Roger's report is published in full, no attempt will be made here to present a summary of the committee reports.

Harold B. Richmond Addresses Luncheon

Dr. Rogers presided at the luncheon on Friday and introduced the speaker, Harold B. Richmond, chairman of the board, General Radio Company, Cambridge, Mass., whose topic was "Observations on Co-Operative Course Training as Viewed by a Manufacturer." Graduates of co-operative courses are a full year ahead in industrial know-how over engineering graduates from conventional engineering courses, Mr. Richmond asserted. The reason for this advantage, he claimed, lies in the fact that such graduates are "house-broken," in so far as industry is concerned, by their part-time experience as employees during their college years.

For successful operation of such type of engineering education, both the college and the employer must exercise intelligent supervision. He had found that undergraduate co-operative students were likely to prefer a piece-rate job during their training period because of the higher income they could derive from it. Candidates for master's degrees, however, were more interested in the experience their co-operative courses afforded them.

In summarizing his general conclusions, Mr. Richmond stated that graduate-course co-operative programs are better than undergraduate ones because of better planning. Employers should have well-organized programs for all co-operative students. Better co-ordination should exist between the employer and the college authorities. It might be necessary to establish some scholarship qualifications as requirements for undergraduates undertaking co-operative courses. The college should put its best man in charge of its co-operative program, one able to convince the manufacturer that the opportunity to participate in the program is beneficial to him. Constant communication between the college and the employer is essential to the success of the program. In his opinion the best job of student training is being done by the large companies. Although a manufacturer may not be able to get the man he needs today, he concluded, the present is a good time to plan for the future when he will be able to get them.

E. W. O'Brien Addresses Annual Dinner

The annual dinner of the Council and its guests was held on Friday evening, and was preceded by a reception. Lieut. Col. L. F. Grant, vice-chairman ECPD, and field secretary EIC, presided. He introduced past-chairmen of the Council, the presidents of participating societies present, and representatives of local engineering societies. Dr. Rogers presented his 1951 report as chairman of the Council, "Service, Motivation, and Support," the text of which appears in this issue. In presenting the report, Dr. Rogers made frequent diversions from the printed text.

Eugene W. O'Brien, vice-president, W. R. C. Smith Publishing Company, Atlanta, Ga., and past-president, ASME, spoke on the topic, "What Junior Engineers Find Important." Mr. O'Brien said that he had been carrying on a personal survey among young engineers as he met them in his travels, in an effort to find out what factors in their success and progress appealed to them as being most important. In analyzing the 428 replies he had received in the course of his inquiries, he found that he could group them into nine classifications. The most frequently men-

tioned factor Mr. O'Brien captioned as "people." Next came the influences of "friendships and wives." What was termed "personality" fell into third place, and "articulateness," "practical experience," "basic engineering fundamentals," "loyalty to the job or company," "planned objectives," and "self-analysis" followed in the order named. Mr. O'Brien added that he had been impressed with the fact that "a fair number (of the men interviewed) mentioned that they were engaged in some sort of civic or public activity, probably a higher percentage than would be found among engineers who have never quite lived up to their civic responsibilities." In conclusion, he said that the college gave the young man the answer to the question, "What do I know?" but that success was dependent on such questions as "How well do I express what I know? whom do I know? and how well do I know people?"

J. P. H. Perry, past-chairman ECPD, moved the vote of thanks.

J. R. Killian, Jr., Speaks at Luncheon

L. Austin Wright, general secretary, The Engineering Institute of Canada, presided at the luncheon on Saturday at which James Rhyne Killian, Jr., president, Massachusetts Institute of Technology, spoke on Student Counseling in an Engineering School. President Killian outlined some novel and interesting work being carried on in this field by his institution and among M.I.T. alumni.

Panel on Training

At the 1950 ECPD annual meeting held at Cleveland, a high point of interest and enthusiasm was the presentation of a six-point program of training to bridge the gap between college and industry by developing programs for the first five years after graduation. A voluminous report, prepared by the ECPD Training Committee, of which A. C. Monteith is chairman, was dramatically presented by the chairmen of subcommittees who had directed the six principal phases of the proposed plan. To implement the plan the Committee recommended the employment of a field secretary or co-ordinator who would assist and advise communities in which the plan might be tried. It was estimated that the expense of this implementation would amount to $20,000 a year for a period of five years, in which time, it was felt, the value and practicability of the plan could be demonstrated.

Following the 1950 meeting, efforts to raise the needed funds, while partially effective, gave rise to a number of questions, as a result of which the Training Committee decided to make a further presentation at Boston. With H. N. Muller, Jr., secretary of the Training Committee, presiding, a panel of six speakers discussed various phases of the plan after Dr. Rogers sketched the history and present status of the committee's work. Mr. Muller spoke briefly on implementation of the six-point program, and introduced each member of the panel in turn. H. P. Hammond, dean emeritus, Pennsylvania State College, spoke convincingly of the great need for the proposed plan J. K. Walter, training supervisor, West Penn Power Company, covered the orientation and training phase; J. C. McKeon, manager, university relations, Westinghouse Electric Corporation, showed how the plan afforded opportunities for continued education; K. B. McEachron, Jr., manager, technical education division, General Electric Company, stressed the need for integrating the young graduate and his family into the life of the community in which his job was located. C. S. Crouse, head, department of mining and metallurgical engineering, University of Kentucky, spoke on professional registration, and F. N. Entwisle, testing and guidance division, Newark College of Engineering, on the importance to young men of self-appraisal.

A general discussion followed the formal presentations by members of the panel. Col. L. F. Grant reported successful initiation of the plan on a modest scale in Canada. Dr. Rogers reverted to the need to implement the program and made it very clear that the problem of implementation is a problem of money. He urged engineers present to locate in their communities companies who would be willing to provide at least $1000 each per year for a period of five years so that a demonstration of the practicability and value of the plan could be made.

Dr. Rogers then introduced S. C. Hollister, dean, college of engineering, Cornell University, who presented the report of a special committee on Adequacy and Standards of Engineering Curricula. This report, mention of which will be found in the chairman's report, pages 989–991 of this issue, will be published in Mechanical Engineering at a later date.

Panel on Guidance

The session on Saturday morning was devoted to the work of the Guidance Committee. Dr. Rogers presented a brief résumé of ECPD's interest in guidance, recalling the work carried on in the field of the pre-engineering inventory and aptitude testing. He then turned the session over to Willis F. Thompson, chairman of the Guidance Committee, vice-president, Westcott and Mapes, Inc., New Haven, Conn., vice-president-elect ASME, who outlined the Committee's current program in a paper entitled, "Wanted—Engineers." A brief résumé of this program will be found in Dr. Roger's report, pages 998–999 of this issue; the text of Mr. Thompson's paper will be found on pages 989–991.

Ernest Hartford, executive assistant secretary ASME and secretary of the Guidance Committee, outlined what the Guidance Committee hoped to accomplish by the program which was to follow his talk, a panel discussion of the high school's point of view on guidance. Members of the panel were: Frederick A. Small, principal, School Department, Norwell, Mass.; Thomas D. Ginn, director of vocational guidance, Boston School Committee; and Aaron Fink, guidance director, School Department, Stoughton, Mass. All these speakers gave objective and stimulating accounts of the work carried on by them, with comments on the Guidance Committee's program and organization and practical suggestions from the viewpoint of the high school. A lively discussion had to be cut off because of lack of time.

Committee Reports

The afternoon session was devoted to presentation of reports of the Education, Recognition, Information, Ethics, and Unity Committees and to the reports of the constituent organizations. Resolutions of thanks were presented and adopted.—G. A. S.

Engineering and Scientific Manpower Programs Planned for AAAS Meeting, Philadelphia, Dec. 28–30

Three sessions devoted to scientific manpower will be featured at the 1951 meeting of the American Association for the Advancement of Science to be held at Philadelphia late in December. ASME is represented on Section M, Engineering, of AAAS.

The conference, which consists of three sessions to be held at the Bellevue Stratford Hotel on Friday, Saturday, and Sunday mornings, Dec. 28, 29, and 30, has been planned by a program committee consisting of Ralph M. Hogan, chairman, Manpower Branch, Human Resources Division, Office of Naval Research; John A. Nagay, secretary, Manpower Branch, Human Resources Division, Office of Naval Research; T. A. Marshall, Jr., Engineering Manpower Commission of Engineers Joint Council; and M. H. Trytten, Office of Scientific Personnel, National Research Council.

The purpose of the conference is to bring before AAAS "some crucial problems involving scientific manpower in the fields of physical, biological, engineering, and social sciences."

Jointly sponsoring the conference are the Engineers' Club of Philadelphia, Engineers Joint Council, Sections I, K, and M of AAAS, and the AAAS Co-operative Committee on the Teaching of Science and Mathematics. The program follows:

Topic: Supply and Demand

9:30 a.m., Friday, Dec. 28, 1951, Burgundy Room, Bellevue-Stratford Hotel, M. H. Trytten, presiding.

Opening remarks, R. M. Hogan.

Scientific Manpower Behind the Iron Curtain, by *D. Rodnick.*

Support of Graduate Student Training, by *H. C. Kelly.*

Scientists and Engineers and Evaluation of America's Resources and Requirements, by *J. F. Hilliard.*

(*Continued on page 1032*)

High Lights of Supply and Demand for Social Scientists, by *E. Sibley.*

Topic: Postbaccalaureate Training

9:30 a.m., Saturday, Dec. 29, 1951, Burgundy Room, Bellevue-Stratford Hotel, George B. Thom, presiding.

Inservice Training of Engineers and Scientists in Industry, by *G. Kleis.*

Inservice Training of Engineers and Scientists in Government, by *W. G. Torpey.*

The Role of the Graduate School in the Development of Human Resources, by *H. E. Longendecker.*

Topic: Selection Techniques: Psychological Background

9:30 a.m., Sunday, Dec. 30, 1951, Burgundy Room, Bellevue-Stratford Hotel, Dael Wolfle, presiding.

Use of the Selective-Service College Qualification Test in the Deferment of Students, by *H. Chauncey.*

The Effectiveness of a Selection Program for Scientists, by *C. J. Lapp.*

Measuring Research Effectiveness, by *J. C. Flanagan.*

Arc-Welding Competition Announced

THE Lincoln Arc Welding Foundation recently announced plans for the fifth annual competition of its Engineering Undergraduate Award and Scholarship Program. The competition is open to all registered undergraduate engineers.

Sixty-three awards ranging from $1000 to $25 will be given for the best papers on arc-welding applications in the design of machines or structures, separate components of machines or structures, and welding research and maintenance projects. In addition, scholarship funds totaling $1750 will be awarded.

Closing date of the competition is May 31, 1952. For rules, write to The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio.

ASCE Organizes Mechanics Division

THE American Society of Civil Engineers has created a technical division to develop studies and research in mechanics pertaining to civil-engineering problems and to promote co-ordination and co-operation with other technical groups.

Linton E. Grinter, dean, graduate school, Illinois Institute of Technology, Chicago, Ill., is chairman of the technical group which is called the Engineering Mechanics Division. Clayton Oliver Dohrenwend, research engineer, department of mechanics, Rensselaer Polytechnic Institute, Troy, N. Y., is secretary.

Both men are members of The American Society of Mechanical Engineers and are well known for their work in the ASME Applied Mechanics Division.

HOWARD COONLEY MEDAL GOES TO HERBERT HOOVER

(Ex-President Herbert Hoover is cited for the Howard Coonley Medal of the American Standards Association by Thomas D. Jolly (*right*), retiring president of ASA. Looking on is Robert E. Wilson who presented Mr. Hoover at the ceremonies.)

Herbert Hoover Receives the Howard Coonley Medal

First Award of Standards Medal Presented to Paul G. Agnew

HERBERT HOOVER, 30th president of the United States, was awarded the Howard Coonley Medal at the annual meeting luncheon of the American Standards Association at the Waldorf-Astoria Hotel in New York, N. Y., on Oct. 24, 1951. He was cited specifically for his work in national standardization projects when he was Secretary of Commerce in the 1920's, and for the importance he placed on administrative standards in the Hoover Commission Report for government reorganization issued in 1949. Mr. Hoover is an Honorary Member of ASME.

Mr. Hoover Pays Tribute to Benefits of Standardization

In his acceptance remarks Mr. Hoover paid a remarkable tribute to the benefits of standardization, when he declared that standards are at the base of all mass production. They make possible more continuous employment by manufacture for stock instead of dependence upon immediate and specialized orders. They have made it possible to conduct this fabulous productive machine with the least amount of spare parts and inventories in the hands of the consumer industries. They have sharpened competition. They have cheapened the cost of production in millions of directions, he said. Thus they have been a factor in our rising living standards. They have enabled thousands of different articles to be placed within the reach of everybody. They do not impose uniformity on the individual, because they make available to him an infinite variety of additions to his living.

Mr. Hoover was presented for the award by Dr. Robert E. Wilson, chairman of the Standard Oil Company (Indiana).

Standards Medal to P. G. Agnew

In recognition of service in the development of voluntary standards, the First Award of the Standards Medal was presented to Paul Gough Agnew for his long service and leadership in the cause of standards which began with the modern standards movement in America. Called from the National Bureau of Standards to serve as secretary and first executive officer of the American Engineering Standards Committee, later renamed the American Standards Association, he guided its growth, built its staff and its membership, and steered its work for nearly 30 years. Possessed of a world-wide view, he played a leading part in the international standards movement which resulted successfully in the formation of today's International Organization for Standardization.

Mr. Agnew was presented for the award by Roger E. Gay, president, Bristol Brass Company, Bristol, Conn.

New ASA Officers Elected

It was also announced at the luncheon that Mr. Gay had been elected president of the American Standards Association to succeed Thomas D. Jolly, vice-president, Aluminum Company of America, Pittsburgh, Pa., retiring after his third term in office.

Edward T. Gushee, vice-president, The Detroit Edison Company, Detroit, Mich., was elected vice-president of the Association.

Mr. Jolly presided over the luncheon.

ASME to Cosponsor Sessions on Artificial Limbs at AAAS Meeting

MEMBERS of the medical and engineering professions will participate in two sessions during the 1951 annual meeting of the American Association for the Advancement of Science to discuss design and technology of artificial limbs. The sessions will be cosponsored by The American Society of Mechanical Engineers and will be held on Thursday, December 27, in Room 200, Municipal Auditorium, Philadelphia, Pa.

The following papers will be presented:

Morning Session

An Engineering Approach to Hydraulic Legs, by *E. M. Wagner*, consulting engineer, San Marino, Calif.

Evaluation and Testing, by *Sidney Fishman*, assistant project director, Prosthetic Devices Study, New York University, New York, N. Y.

Techniques for Testing Legs, by *Alan Nathan*, research assistant, Prosthetic Devices Study, New York University, New York, N. Y., and *Burton Walder*, electronics scientist, Prosthetic and Sensory Aids Service, Veterans Administration.

Alignment Principles, by *Chester C. Haddan*, president, American Board for Certification of the Prosthetic and Orthopedic Appliance Industry, Inc., and *William Tosberg*, orthopedic technologist, Prosthetic Testing and Development Laboratory, Veterans Administration.

Afternoon Session

Functional Requirements of Artificial Arms and Terminal Devices, by *Lieut. Col. Maurice Fletcher*, MSC, USA, director, Army Prosthetics Research Laboratory, Forest Glen, Md.

A Skinlike Plastic Glove—A Union of Chemistry, Art, and Technology, by *Fred Leonard*, chief, plastics development branch, Army Prosthetics Research Laboratory, Forest Glen, Md.

Cineplasty—Muscle Engineering, by *Col. August W. Spittler*, MC, USA, Walter Reed Hospital, Washington, D. C.

Future Research in Prosthetics, by *Eugene F. Murphy*, assistant director of research, Prosthetic and Sensory Aids Service, Veterans Administration.

Motion-picture films and demonstrations of artificial limbs will aid several of the authors in the presentation of their subjects.

Dr. Eugene F. Murphy, assistant director of research, Prosthetic and Sensory Aids Service, New York, N. Y., is chairman of the AAAS Section "M" committee in charge of the program.

Frank D. Carvin, Mem. ASME, is secretary of the Section "M" Engineering of the AAAS.

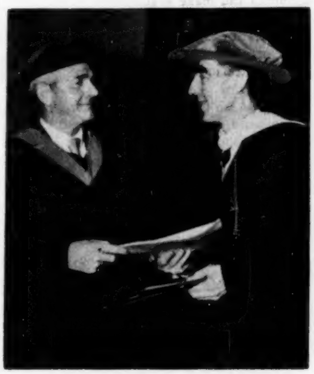
Honored by the Society for the Advancement of Management

THE Society for the Advancement of Management held its Annual Fall Conference on Productivity, Cost Reduction, and Human Relations Nov. 1 and 2, 1951, at the Hotel Statler, New York, N. Y.

The conference included 26 sessions on productivity, cost reduction, and human relations. Presentation of the Emerson Trophy Award to the most outstanding SAM chapter for the past year and Membership Key Award presentations were made at the Thursday luncheon meeting.

The outstanding Human Relations Award for 1951 was presented to Glenn L. Gardiner, vice-president of Forstmann Woolen Company, Passaic, N. J., editor of *Management Information*, past-president of the New Jersey State Chamber of Commerce, associate member, National War Labor Board, World War II, and one of the guest speakers for the evening. The Frederick Winslow Taylor Key for 1951, the highest award bestowed by American Management, was awarded to Dean Donald K. David, Harvard University, Graduate School of Business Administration, Boston, Mass., and a director of R. H. Macy and Company, Inc., General Electric Company, Ford Motor Company, and the First National Bank of the City of New York. He was also a guest speaker at the banquet.

People



Inauguration at Stevens

WILLIS H. TAYLOR, JR., chairman of the board of trustees, Stevens Institute of Technology, hands the college charter to the new president, Dr. Jess Harrison Davis, Mem. ASME, at inauguration ceremonies, Oct. 12, 1951. James M. Todd, past-president ASME, represented the Society at the inauguration.

CHARLES H. JENNINGS, engineering manager, welding department, Westinghouse Electric Corporation, Pittsburgh, Pa., was elected president for 1951–1952 of the American Welding Society recently.

WALTER H. BRUCKNER, research associate professor of metallurgical engineering, University of Illinois, was honored with the 1951 Lincoln Gold Medal of the American Welding Society at its annual meeting recently. Mr. Bruckner was the author of a paper judged to be the "greatest contribution to the advancement and use of welding for the year."

WALTER L. SEELBACH, president, Superior Foundry, Inc., Cleveland, Ohio, was given the Gold Medal Award of the Gray Iron Founders' Society at its 23rd annual meeting in Chicago recently. He was honored for his "outstanding contribution of leadership and unselfish service to the society and to the gray-iron industry generally."

ERNEST SZEKELY, Mem. ASME, president, Bayley Blower Company, Milwaukee, Wis., has been nominated for president of The American Society of Heating and Ventilating Engineers in 1952.

CHALMER GATLIN KIRKBRIDE, vice-president and director, Houdry Process Corporation, has been chosen to receive the 1951 Professional Progress Award in Chemical Engineering, sponsored by the Celanese Corporation of America. The award, which is administered by the American Institute of Chemical Engineers, carries with it a prize of $1000 and will be presented at the AIChE Annual Meeting in December.

WILLIAM A. PEARL, director, Washington State Institute of Technology, and chairman, Department of Mechanical Engineering, Washington State College, Pullman, Wash., has been appointed acting president, Washington State College, by the Board of Regents. Dr. Pearl is secretary of ASME Region VII and served on the 1951 Nominating Committee.

WALKER L. CISLER, executive vice-president, The Detroit Edison Company, Detroit, Mich., represented ASME as Honorary Vice-President at the inauguration of Dr. Harlan A. Hatcher as eighth president of the University of Michigan, Ann Arbor, Mich., Nov. 27, 1951.

JAMES N. GOODIER, Mem. ASME, professor, applied mechanics, Stanford University, recently was appointed Visiting Lecturer at Harvard University in the Division of Applied Science for the first half of 1951–1952.

ARTHUR KANTROWITZ, professor, aeronautical engineering, and engineering physics, Cornell University, will be Visiting Lecturer in the same division of the University for the second half of the year.

Columbia University to Raise Funds for Engineering Center

HERBERT HOOVER, former President of the United States, Dr. Irving Langmuir, Nobel Prize winner, and other prominent persons spoke at a recent dinner in New York, N. Y., marking the opening of a $22,150,000 drive for a proposed new engineering center to be established at Columbia University, New York, N. Y. Plans for the new engineering center were announced by Dr. John R. Dunning, dean of engineering, acting on behalf of General Dwight D. Eisenhower, the university's president, now on leave to the Army. In a message from General Eisenhower, read to the 400 persons present, the General strongly supported the new center. A Columbia University Engineering Center Development Fund has been set up to seek financial aid for the project.

ASME NEWS

President of EIC and ASME Sign Agreement of Co-Operation

ON October 26, 1951, at ASME Headquarters in New York, Ira P. Macnab, president of The Engineering Institute of Canada, and J. Calvin Brown, president of The American Society of Mechanical Engineers, signed an agreement of co-operation between the two societies. The text of the agreement follows:

Agreement of Co-Operation Between The Engineering Institute of Canada and The American Society of Mechanical Engineers

By this agreement, the Councils of The American Society of Mechanical Engineers and of The Engineering Institute of Canada, pledge continuing mutual co-operation, and establish an agency to be known as the ASME-EIC International Council for fostering such co-operation.

This agreement supersedes the previous agreement adopted in 1943, and as amended in 1945 and 1948.

The International Council

Each society shall appoint four representatives, one if possible from the current membership of each governing body, to constitute a continuing ASME-EIC International Council which shall select its chairman and secretary and shall meet at least annually.

Suggested Avenues of Co-Operation

The following shall guide but not limit the International Council in its future work:

(1) *Meetings*

To facilitate the interchange of experience between members of the two societies, the International Council will explore all opportunities for useful joint meetings and further the participation of members of each society in meetings of the other.

(2) *Member Organizations*

(*a*) Each society will continue to encourage co-operation through joint meetings and other activities between neighboring ASME Sections and EIC Branches. The International Council will review such activities and make suggestions.

(*b*) The International Council will review proposals for the establishment of organizations of one society in the field of influence of the other and seek agreement between the two societies as to the solution in the best interest of the professions of the two nations, after consulting the engineers in the locality of the proposed organizations.

(3) *Student Organizations*

(*a*) Each society will continue to encourage co-operation, through joint meetings and other activities, between neighboring ASME Student Branches and EIC Student Sections. The International Council will review such activities and make suggestions.

(*b*) The International Council will review proposals for the establishment of organizations of one society in the field of influence of the other and seek agreement between the two societies as to the solution in the best interest of the professions of the two nations, after consulting the engineers in the locality of the proposed organization.

(4) *Secretary Membership*

Each organization shall elect the secretary of the other to membership without dues.

(5) *Membership Privileges*

The International Council will develop plans for interchange of membership privileges with a combined rate of dues.

(6) *Technical and Program-Making Activities*

The International Council will review annually the plans and programs of the technical and program-making activities of each organization and make recommendation for (*a*) broadening the activities of one so that they may be of greater value to the members of the other, (*b*) participation by members of one in those activities of the other which may be useful to either or both, and (*c*) joint projects that may be mutual to the engineers of Canada and the United States.

Recorded Agreements

I *Representative of ASME on EIC Council*

A By-Law of The Engineering Institute of Canada provides that organizations having a co-operative agreement with the Institute may appoint a representative to the Council of the the Institute. Such representative must be a member of both organizations.

On January 24, 1947, ASME Council authorized such an appointment.

II *Attendance at Meetings*

Members of each organization enjoy the privileges of attendance at meetings of the other on the same basis. (Approved: EIC December 11, 1948—ASME January 27, 1949)

Student members of each organization enjoy the privilege of attendance at meetings of the other on the same basis as student members of the other. (Approved ASME September 20, 1950—EIC November 18, 1950)

III *Transfer of Students to Junior*

ASME has incorporated the list of Canadian engineering schools as a part of the ASME list of approved schools and graduates of these schools who were Student Members of EIC will be admitted to Junior Membership in ASME under the same procedures that govern the transfer of graduates who were Student Members of ASME.

EIC will admit to Junior Membership graduates who were Student Members of ASME under the same procedures that govern the transfer of graduates who were Student Members of EIC.

IV *Special Student Rates for Society Journals*

ASME has authorized a bulk rate of \$3.50 (plus postage) per annum for MECHANICAL ENGINEERING to students in Canadian Engineering Schools where EIC has student members but where ASME does not have Student Branches.

EIC has authorized a rate of \$2.00 per annum for the *Engineering Journal* to ASME Student Members.

J. Calvin Brown (signed)
President, The American Society of Mechanical Engineers

Ira P. Macnab (signed)
President, The Engineering Institute of Canada,
October 26, 1951

Ballot on Amendments to the Constitution

AS reported by the tellers, A. D. Blake, W. H. Byrne, and H. Carlson, letter ballots received from members of The American Society of Mechanical Engineers on Amendments to the Constitution were counted on November 5, 1951, with the following results.

		For	Against
1	Indemnification Provision................ (*Addition of Section 6 to Article C6*)	11205	388
2	Appointment of Assistant Secretaries and Assistant Treasurers. (*Change in Article C8, Section 2*)	10863	732

The total number of ballots cast was 11,779; of these 184 were defective; 2, no vote on (1).

AT THE ASME-AIME 14TH ANNUAL FUELS CONFERENCE HELD AT ROANOKE, VA., OCT. 11–12, 1951

(*Left to right:* Charles T. Holland, general chairman, 1951 Joint Fuels Conference; Carl E. Miller, chairman, Fuels Division, ASME; Carroll A. Garner, chairman, Coal Division, AIME; and Fred K. Prosser, co-chairman, 1951 Joint Fuels Conference.)

Attendance High at 14th Joint Fuels Conference Held in Roanoke, Va.

THE Fourteenth Joint Fuels Conference sponsored by the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers was held at the Roanoke Hotel, Roanoke, Va., Oct. 11–12, 1951. The two-day meeting attracted an attendance of some 300 engineers and coal-company executives who participated in a program of four technical sessions, a luncheon, and a banquet.

Among the topics that attracted large audiences and animated discussion were the desliming of fine fuels, the bettering of fuel and equipment consulting services for small steam-generating plants, the changing characteristics of storage coal, problems of air pollution from gob piles, the filter-cake size consist, and moisture relationships of the various coals.

Coal Praised as Locomotive Fuel

At the luncheon on Oct. 11, R. H. Smith, president, Norfolk and Western Railway Company, praised the much maligned coal-burning locomotive as the most economical and reliable prime mover whose record cannot be bettered by any other existing type of railroad power. Mr. Smith also gave figures to support his assertions.

A study of 23 principal railroads in this country, Mr. Smith said, showed that his company's 64,766 gross-ton-miles per train hour in 1950 surpassed all the country's 22 railroads for that year. In 1951 his company expects to better its own figures and will again top the country's 22 railroads, Mr. Smith declared.

Gross-ton-miles per train hour is generally accepted by railroad people as the best measure of all-round freight operating efficiency. It is the total tonnage handled, multiplied by the miles hauled, and divided by the total road train-hours. The Norfolk & Western is the largest American railroad, in fact the only American railroad of any substantial size, which uses coal exclusively as a fuel for its locomotives.

As further "proof of what can be done with the modern coal-burning locomotive," Mr. Smith said, the same study revealed that his road's CT ratio in 1950 was lower than that of any of the other 22 railroads. The CT ratio is a yardstick for measuring operating efficiency expressed in actual money value. It is that portion of each dollar of gross revenue expended for labor and supplies in conducting transportation.

The Norfolk & Western head said this was achieved despite lower average freight revenue per ton-mile than the other 22 railroads. Figures for operating results so far this year indicate the N & W will maintain this position in 1951, he said.

Mr. Smith said the present activities of his company in developing other types of coal-burning locomotive stem from its realization that the conventional steam locomotive boiler has just about reached its limit in boiler pressure and cannot go appreciably higher. Barring unforeseen difficulties, it expects to have a coal-burning steam turbine, electric-drive locomotive undergoing road tests on its line before the end of 1952.

Plans for this locomotive were developed together with the Babcock & Wilcox Company, Westinghouse, and Baldwin Locomotive. Preliminary tests have been completed and construction has begun. The locomotive will utilize a water-tube boiler carrying 600 psi boiler pressure (considerably more than double ordinary locomotive boiler pressure) at 900 F steam temperature.

A. R. Mumford Honored

Albert R. Mumford, past vice-president ASME, and research engineer for Combustion Engineering-Superheater, Inc., received the Percy Nicholls Award at a ceremony at the banquet on Thursday. The presentation was made by A. W. Thorson, supervising engineer of United Engineers and Constructors Inc.

The award honors Mr. Mumford for his contributions to important advances in utilization of fuels through his research work on the combustion of coal, heat transfer, and circulation in steam generators. Mr. Mumford has also directed the work of the ASME Special Research Committee on Furnace Performance Factors, the reports of which form an important contribution to engineering literature on heat absorption by boiler furnaces.

A graduate of the Massachusetts Institute of Technology in 1918, Mr. Mumford spent four years as assistant fuels engineer of the U. S. Bureau of Mines, followed by over fifteen years as research and design engineer with the New York Steam Corporation. From 1938 to 1942 he served as assistant director of research with the Consolidated Edison Company of New York, and then joined the research department of Combustion Engineering.

Active in ASME Committee Work

Mr. Mumford has long been active in committee work of The American Society of Mechanical Engineers, the National District Heating Association, the American Society of Heating and Ventilating Engineers, and the American Society for Testing Materials. He served as vice-president of the ASME from 1946 to 1950. Over the years he has contributed many valuable articles to technical publications in the steam-power field.

A. R. MUMFORD

(1951 recipient of the Percy Nicholls Award, presented annually by the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers.)

Following the presentation of the Percy Nicholls Award, Walter S. Newman, president, Virginia Polytechnic Institute, spoke on "The Importance of Education to the Coal Industry in America."

An interesting program consisting of a bridge-canasta party, a tea, a luncheon, and visits to the Natural Bridge of Virginia and the campuses of the Virginia Military Institute and Washington and Lee University added to the pleasure of wives of delegates to the conference.

Actions of the ASME Executive Committee

At a Meeting in New York, N. Y., Held on Oct. 26, 1951

A MEETING of the Executive Committee of The American Society of Mechanical Engineers was held in the rooms of the Society, Engineering Societies Building, New York, N. Y., on Oct. 26, 1951. The following persons were present: J. Calvin Brown, president, and chairman of the Committee; F. M. Gunby, vice-chairman; and A. C. Pasini; members of the Committee: R. J. S. Pigott, president-elect; E. J. Kates, assistant-treasurer; H. R. Kessler, vice-president; H. E. Martin, director at large; H. E. Whitaker, chairman, Finance Committee; W. P. Saunier, chairman, Organization Committee; Ernest Hartford, executive assistant secretary; Frances Selig, assistant to the secretary; and A. R. Mumford, member, Special Committee on Society Policy.

The following actions of the Committee are of general interest:

Members of ASME Staff

Sincere appreciation of loyal and faithful services was expressed to Ernest Hartford (40 years), Jean A. Brown (35 years), Ivah L. Martin (30 years), and Louisa C. Call and Ricky Hoffman (25 years).

Development Fund

Authorization was voted by the Council in 1950 to build up the Development Fund established in 1945, and James D. Cunningham and R. H. Bacon have undertaken to do so. The Executive Committee authorized Messrs. Cunningham and Bacon to proceed and approved an expenditure of $5000 for that purpose.

Dues for Members in Other Countries

Continuance of Society policy on payment of dues by members in other countries was voted. Members residing in Canada may pay dues in Canadian currency if 1951–1952 dues are paid on or before Dec. 1, 1951; in U. S. dollars or equivalent if paid after that date. Members in foreign countries (Canada excepted) are required to pay dues in U. S. dollars. If such payment becomes excessive, a member may, on request, be placed on a suspended-dues list without service from the Society. A young foreign student engineer, in this country for one year, may pay student member dues and receive MECHANICAL ENGINEERING and attend meetings.

Members in the Armed Forces

A revised Policy for Members in the Armed Services was approved. Copies of this policy may be obtained from the Secretary.

Dues-Exempt Members

It was reported that 152 members of the Society became dues-exempt members in 1951 because they had paid dues for 35 years, or had reached the age of 70 years and had paid dues for 30 years.

Committee on Society Policy

On Jan. 23, 1951, the Executive Committee authorized a Special Committee on Society Policy to report to the Council, after reviewing the Society's objectives and organization, what changes, if any, in objectives and organization need be made for better service to members. The committee consists of E. G. Bailey, chairman, H. V. Coes, A. R. Mumford, F. M. Gunby, and A. L. Penniman, Jr. The report of the committee was presented by Mr. Mumford and was accepted in principle. Copies have been sent to members of the Council for discussion at the 1951 Annual Meeting. The Executive Committee voted to establish the Committee on Society Policy as a continuing committee.

Research Committee

On recommendation of the Organization Committee approval was voted of establishment of Research Committees on Low-Temperature Flue Gas, Mechanical Pressure Elements, and Heat-Conduction Charts.

Approval was voted of extension of agreements covering research activities with the Department of the Interior, Ohio State University Research Foundation, and Battelle Memorial Institute.

Codes and Standards

The Executive Committee authorized Alex D. Bailey, J. D. Cunningham, B. P. Graves, H. B. Oatley, and F. S. G. Williams to serve as an ASME delegation at an informal discussion with representatives of the American Petroleum Institute looking toward an attempt to develop a joint API-ASME Unfired Pressure Vessel Code. It recommended that the Finance Committee appropriate $2500 for international standards activities for the period of one year.

Student Award

The 1951 Undergraduate Student Award was granted to Philip Levine of the University of Connecticut, for his paper, "An Experimental Analysis of Flame Propagation in Cylindrical Tubes."

Sections and Branches

Approval was voted of the establishment of the Delaware Section to replace the Wilmington Subsection of the Philadelphia Section. Full Section status for the present Westmoreland Subsection of the Pittsburgh Section was approved. Combination of the day and evening student branches of the Cooper Union School of Engineering into one branch was approved.

1951 Regional Delegates Conference

The Executive Committee voted to adopt the statements of the Council on the recommendations of the 1951 Regional Delegates Conference. Copies of these statements may be obtained by writing to the secretary.

Roy V. Wright Lecture

Selection was approved of W. G. Mullendore, president, Southern California Edison Company, Los Angeles, Calif., as the Roy V. Wright lecturer at the 1951 Annual Meeting.

EIC-ASME International Council

A revised agreement between The Engineering Institute of Canada and The American Society of Mechanical Engineers (see this issue) was approved.

Joint Awards

The following joint awards were reported:

Hoover Medal, 1951, to William L. Batt, past-president and honorary member ASME.

John Fritz Medal, 1952 to E. G. Bailey, past-president ASME.

Gantt Medal, 1951, to Thomas Roy Jones.

Recent Deaths

The Executive Committee noted with profound regret the death of Dugald C. Jackson, honorary member ASME, on July 1, 1951, and of Erik Oberg, treasurer of the Society, 1925–1935, on Oct. 22, 1951.

Appointments for 1952

On recommendation of the Organization Committee, appointments to Boards, Committees, and joint activities were approved. These appointments will be incorporated in the "Personnel of Council, Boards, and Committees" to be issued early in 1952.

Presidential Appointments

The following presidential appointments were confirmed:

E. H. Barlow, John Haydock, C. W. Obert as Tellers of Election 1952 Officers.

B. P. Graves, chairman; T. R. Olive, Crosby Field, Warner Seely, and E. C. Hutchinson—Committee on Revision of Honors (authorized by Council, June 10–11, 1951).

James R. Van Dyke, inauguration of president, University of Nevada, Reno, Nev., June 11.

E. G. Bailey, 75th Anniversary, American Chemical Society, New York, N. Y., Sept. 5, 1951.

E. A. Allcut, A. L. London, A. P. Colburn, H. L. Dryden, and W. E. Lobo, Heat Transfer Discussion, London, Sept. 11–13.

J. D. V. Dubus, 75th Anniversary, Association des Ingenieurs Sortis des Écoles Speciales de Gand, Belgium, Sept. 8–10.

R. L. Sutherland, dedication of Charles R. Robertson Lignite Research Laboratory of Bureau of Mines, Grand Forks, N. D., Sept. 29.

R. L. Daugherty, presentation of Daniel Guggenheim Medal, Society of Automotive Engineers, Los Angeles, Oct. 5.

James M. Todd, H. R. Kessler, G. R. Hahn, inauguration of president, Stevens Institute of Technology, Hoboken, N. J., Oct. 12.

H. R. Kessler, annual dinner, American Institute of Consulting Engineers, New York, N. Y., Oct. 22.

James D. Cunningham, NMC-NAM Sponsoring Committee, International Productivity Mission, ECA.

A. D. Blake, W. H. Byrne, and H. C. R. Carlson, Tellers on Constitutional Amendments.

F. M. Gunby and A. L. Penniman, Jr., additions to Special Committee on Society Policy.

Walker L. Cisler, inauguration of president, University of Michigan, Nov. 27.

LONG ISLAND DIVISION OF ASME METROPOLITAN SECTION HOLDS ITS FIRST DINNER MEETING, OCT. 25, 1951, WITH J. CALVIN BROWN, PRESIDENT ASME, AS SPEAKER

(*At the head table:* E. S. Bance, Mrs. John de S. Coutinho, Mrs. J. D. Adiletta, Mrs. A. Ehbrecht, W. S. Johnston, W. J. Byrne, Mrs. H. R. Kessler, J. Calvin Brown, H. R. Kessler, Mrs. W. J. Byrne, and Ernest Hartford.)

Junior Forum

Engineering in Non-Engineering Industries

By Joseph Schmerler[1]

LAST month the Junior Forum inaugurated its new series of articles dealing with the engineering experiences of Junior Members of ASME. This was a direct result of a desire, expressed by Juniors in a survey, to read of engineering work done by members of their own standing. The first article dealt with lignite-coal mining in North Dakota. As a change of pace, and a different approach to engineering, this month's article deals with engineering in non-engineering industries.

Association of Specialists

During the last ten or fifteen years the technical profession has become an association of specialists. Like the sciences, where biology and chemistry have been broken down further into biochemistry and chemical biology, engineering assigns a very specific subtitle to a man's daily effort. This has been brought about, mainly, through the severe refinement in personal contribution necessary to today's technological advancement. Yet, there remains an area where this refinement is absent. The engineering involved is applied to what we might call non-engineering industries.

This group of industries has only lately become aware that modernization of its production facilities and techniques is necessary. When originally organized, these industries required little or no mechanical equipment. Of course, some were added as time went on but such a patchwork arrangement never really tackled the production problem at its source. A few examples of such industries with which the author has been associated are the production of men's hats, fur dressing and dyeing, textile silk-screen printing, and greeting-card manufacture.

Men's hats, today, are camouflaged to hide imperfections. If you rub a handkerchief over almost any man's hat, the color will come off. This is due to a surface powder which is applied to cover uneven dyeing. In the final stages of production, the hat is "wiped" by a "craftsman" who supposedly is the only one capable of turning out a good hat. There are some excellent pieces of machinery used in other stages of hat production, yet the job was never completed to include the whole process.

Last year a fur dyer produced a beautiful new shade of mink. The coatmakers rushed to place orders but the dyer found that he couldn't reproduce the shade in volume production. The engineering answer is simple. He should have simulated volume methods in making samples. Technical industries have extensive research facilities but other manufacturers can't seem to grasp the approach. The writer has had a part in remedying this situation as well as substituting mechanical means for hand operations.

In the writer's experience, textile silk-screen printing has been the worst offender in outmoded methods of production. Seventy to eighty per cent of all silk screening is still done by hand. Only in the last two or three years have mechanical screening machines been placed on the market. These industries, together with many others, need modernization. Young engineers with imagination and initiative should take to this task. The job is challenging—besides, the remuneration is good. A greeting-card manufacturing plant will be used as an example of how a modernization program was installed by the writer.

For the past five years the greeting-card business has been booming. Every occasion warrants a card. There is even a card for a birthday on Valentine's Day. Not many people have birthdays on that day, but its a good advertisement. Millions of cards are produced a week so the manufacturing facilities should be up to date. However, the means and methods of production were outmoded and an almost complete overhaul was necessary. Almost everything was done by hand. Machines cut and folded the printed sheets but hands did everything from then on. Workers sitting at tables trimmed the cards, even folded some, and placed them in a storage box. The card then waited for the boxing section to place it in a box, together with envelopes, and put the box in a carton, and finally the carton waited to be placed into storage. Slow handling, intermediate storage space, waiting time, and the resulting spoilage were expensive. The answer was continuous operation of trimming, boxing, cartoning, and storage. In other words, conveyerized manufacture.

Two conveyers were built and placed into operation in a corner of the plant. Management was not yet sold on the idea and had to be shown. Some skeptics said it would never work; it had never been done that way before. However, the new system worked so well that conveyers could not be built fast enough once management saw the production comparison figures. We built twenty-five conveyers with one swoop. These were installed in the main plant and other sections were soon duplicated.

The engineering experience gained on this type of job is invaluable. First, the operation of the system had to be visualized; and second, it had to be constructed. No venders' catalogs to choose from but engineering from the design on through to the installation of the equipment. The correct number of workers per conveyer, according to the operation, dictated the length. The speed of the conveyer was arrived at through time studies of the operations and made variable within the correct range. The construction dimensions and materials were determined according to availability and cost. With the design checked and approved, construction was made and the plan placed in operation. When everything started working smoothly and the workers became accustomed to the new methods, an incentive system was instituted. It was the first time incentives were successfully applied to this type of work.

This program involved both mechanical and industrial engineering. It had to be a marriage of the two for successful completion. Of more direct mechanical engineering was the

[1] Design Engineer, Celanese Corporation, New York, N. Y. Jun. ASME.

design of new flock-coating equipment. Flock is that material on greeting cards which adds fuzz to a cat, snow at Christmas, or simply a velvety touch.

The older equipment was very noisy and did not do a very good job. Flock is composed of individual rayon fibers which are thrown onto the card after paste has been applied in the desired outline. After the flock is applied, the card is vibrated in an effort to make the individual fibers become erect. In some measure this method is successful.

The foolproof method whereby every fiber must stand upright is through the utilization of electrostatic precipitation. This technique employs a sound engineering principle which has been used in smoke abatement, fly-ash recovery, and sandpaper manufacture. The flock fibers are about one thirty second or one sixteenth of an inch long depending on how high a pile is desired. Since each fiber will exhibit a definite polarity, however slight, on an end, the fiber will correctly erect itself when placed in a strong electrostatic field. With paste on the card, and the card in the electrostatic field, the flock is applied. The resulting effect is so far superior to anything done by vibration that there is almost no comparison.

The necessary equipment to accomplish this result was connected to a conveyer for continuous operation and the system was complete. It required a good deal of engineering and experimentation but the outcome was never in doubt because the underlying principle was sound.

Modernization Needed

There are a good many other businesses, large and small, where modernization needs to be applied. A good many everyday products need improvement. If you have an idea, use it. The manufacturer is quite likely looking for such an improvement but can't do it himself. There's always a better method to do any particular job.

ASME System of Honors Under Review by Special Committee

THE system of granting engineering awards developed by The American Society of Mechanical Engineers is currently under review to determine whether under present conditions ASME awards properly give "recognition of meritorious contributions to engineering" and whether these awards serve adequately "to encourage and inspire" talented engineers to work for greater professional achievement.

At its meeting in Toronto, Canada, the Council authorized appointment of a special committee to (1) study revision of Society endowments and to determine whether these can be altered to provide for multiple recipients, and (2) to investigate whether new funds can be secured either from new endowments, subscriptions from ASME members, or by appropriation from funds of the Society for establishment of new awards.

Pres. J. Calvin Brown recently appointed the following members to undertake the honors review: B. P. Graves, member of Council; T. R. Olive, and Crosby Field, Board on Technology; Warner Seely and J. B. Ennis, Board on Honors.

ASME System of Honors

The ASME system of honors is designed to give recognition for distinguished service to the engineering profession and to encourage contributions to engineering literature.

Among the distinguished-service honors are the following: *Honorary Membership* for acknowledged professional eminence; *ASME Medal* for distinguished service in science and engineering; *Holley Medal* for a unique act of genius; *Spirit of St. Louis Medal* for meritorious service in aeronautics; and in co-operation with Pi Tau Sigma, the *Richards Memorial Award* for outstanding achievement in mechanical engineering within twenty to twenty-five years after graduation; and the *Pi Tau Sigma Gold Medal Award* for outstanding achievement in mechanical engineering within ten years after graduation.

Encourage Advancement of Profession

The ASME honors created to encourage engineers to advance their profession by contributing to engineering literature are: *Worcester Reed Warner Medal* for an outstanding contribution to permanent engineering literature: *Melville Prize Medal* for original work for the best original paper or thesis on any mechanical-engineering subject; the *Junior Award* for the best paper by a junior member during the year; *Spirit of St. Louis Junior Award* for the best paper on an aeronautic subject by a junior member of the Society; the *Charles T. Main Award*, given to a student member for the best paper on the influence of the engineering profession on public life; and the *Postgraduate and Undergraduate Student Awards* for the best papers by a postgraduate and an undergraduate student member of the Society.

Of these awards only the Junior Award makes provision for multiple authorship. All other awards are specifically limited to papers written by an individual.

Plant Maintenance

BASIC and specialized plant maintenance problems in many different fields of industry will be taken up at the third Plant Maintenance Conference to be held concurrently with the Plant Maintenance Show at Convention Hall, Philadelphia, Pa., Jan. 14–17, 1952. Thirty-four separate discussions are scheduled at which such subjects as maintenance costs, inspection methods and records for preventive maintenance, training maintenance workers, and planning and scheduling maintenance work, will be discussed. There will also be round-table discussions on maintenance in different industries including, aircraft, food, glass, oil refineries, printing, and textile plants.

ASME Calendar of Coming Events for 1952

March 24–26, 1952
ASME Spring Meeting, University of Washington, Seattle, Wash.
(Final date for submitting papers was Nov. 1, 1951)

June 15–19, 1952
ASME Semi-Annual Meeting, Sheraton-Gibson Hotel, Cincinnati, Ohio
(Final date for submitting papers—Feb. 1, 1952)

June 19–21, 1952
ASME Applied Mechanics Division Conference, The Pennsylvania State College, State College, Pa.
(Final date for submitting papers—Feb. 1, 1952)

June 23–27, 1952
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
(Final date for submitting papers—Feb. 1, 1952)

June 26–28, 1952
ASME Applied Mechanics Division, West Coast Conference, University of California, Los Angeles, Calif.
(Final date for submitting papers—Feb. 1, 1952)

Sept. 8–11, 1952
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
(Final date for submitting papers—May 1, 1952)

Sept. 8–12, 1952
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland Auditorium, Cleveland, Ohio
(Final date for submitting papers—May 1, 1952)

Sept. 22–24, 1952
ASME Petroleum Mechanical-Engineering Conference, Hotel President, Kansas City, Mo.
(Final date for submitting papers—May 1, 1952)

Oct. 30–31, 1952
ASME Fuels and AIME Coal Divisions Joint Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.
(Final date for submitting papers—June 1, 1952)

Nov. 30–Dec. 5, 1952
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1952)

Fellowships Available at R. P. I. for Teachers of Mathematics

RENSSELAER Polytechnic Institute, Troy, has been given 50 fellowships for awards to teachers of mathematics in secondary schools of 13 eastern states. The fellowships are established in an annual program by the General Electric Company, with the first 50 awards to take effect for six-week summer terms at Rensselaer starting next July 7. The company has already established similar math fellowship programs for summer work at Union College and Case Institute of Technology.

The Awards at Rensselaer will be made by a special committee headed by Dr. Edwin B. Allen and teachers will be informed on how and when to apply. The fellowships pay all tuition, fees, and maintenance costs for the six-week summer term.

ASME Elects Six Fellows

THE American Society of Mechanical Engineers has honored six members by electing them to the grade of Fellow.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and must have been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who, by virtue of their contribution to their profession and to the Society, were so honored are:

Charles Balough

Charles Balough, president and general manager, Hercules Motors Corporation, Canton, Ohio, since 1915, actively directs all branches of the business. Under his supervision and management more than a hundred gasoline-engine models and 30 Diesel-engine models were developed by the company. Approximately two million gasoline engines and 150,000 Diesel engines have been produced to date. During World War II Mr. Balough led his company in rolling up an enviable production record which includes 678,212 engines, totaling 68 million hp. He holds numerous patents on internal-combustion engines and their parts.

Charles Francis Dixon

Charles F. Dixon, supervising engineer, United Engineers and Constructors Inc., Philadelphia, Pa., has been associated with the power industry since 1902. In 1914 he was employed by the Interborough Rapid Transit Company, New York, N. Y., as assistant engineer, under Henry G. Stott, and during this period, he represented Mr. Stott in the early sessions of the ASME Boiler Code Committee. Since 1918 he has been connected with the United Engineers and Constructors Inc., and their associated companies, as supervising engineer. He is now in charge of design of the Edge Moor Station, which is a large modern station being constructed for the Delaware Power and Light Company. Mr. Dixon is an outstanding designer of steel-mill and utility power generating facilities, and has been widely recognized for his work in this field for many years. He holds patents on a pipeline joint and a mercury tripping device.

Jefferson Cameron Falkner

Jefferson C. Falkner, manager, electric-production department, Consolidated Edison Company of New York, Inc., who in addition to his work as production manager of one of the largest electric-utility systems in the world, has made an outstanding contribution to the economical operation of high-temperature high-pressure turbines and boilers. Mr. Falkner initiated a research project which has resulted in reducing the average starting time in large high-temperature units which are shut down during the night from $2^1/_2$ hours to 15 minutes. Similarly after long shutdown with the boiler and turbine at substantially room temperature the average starting time has been reduced from 4 hours to $2^1/_2$ hours. His technical papers describing the method have been published by the Society.

Henry Drake Harkins

H. Drake Harkins, supervising engineer, engineering department, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del., holds an impressive record in the engineering field, particularly in power plants. In the early 1920's Mr. Harkins was instrumental in directing du Pont powerhouse design to what were then high pressures and the use of pulverized coal, both radical departures for the company, and these plants are still in effective operation. He also pioneered in pulverized-coal firing for small wet-bottom industrial boilers. As far as it can be ascertained, Mr. Harkins was the first to propose the use of a thoroughfare heater in the heat cycle using noncondensing turbines. He has been especially active in working out engineering-economic problems in the so-called co-operative plants where utilities furnish adjacent industries with both steam and electricity. His interest in this respect began as early as 1927 with the company's Deepwater Station, N. J. Similar projects followed later at Baton Rouge, La., Clinton, Iowa, and Louisville, Ky. The new Greenwich Station (now building) was promoted by him in co-operation with the Atlantic City Electric Company. An originator in his field, he realized that many accepted practices in power-plant design were not economically feasible when applied to the needs of the chemical industry. Thorough analysis of the subject coupled with original thought resulted in the use of smaller less costly power plants rather than larger and costlier installations at du Pont.

Harry B. Joyce

Harry B. Joyce, self-employed consulting engineer, Erie, Pa., is a specialist in the design of complete power plants including steam and electric systems. He received his early engineering experience with the New York Edison Company. In 1925 he joined the Burke Electric Company, Erie, Pa., as application engineer and specialist in the development of synchronous motors. Six years later in Erie he started his own private practice as a consulting engineer. During World War I he was a major in the Construction Division of the U. S. Army, responsible for hundreds of steam and refrigeration plants and all electrical installations in Army installations throughout the United States. Mr. Joyce is prominent in Pennsylvania engineering activities. He served for ten years on the Board of Examiners for Professional Engineers. During World War II he was in charge of the War Production Board in Erie. Mr. Joyce has twice served the Society on national meeting committees. His more recent participation was in 1949 when the ASME Fall Meeting was held in Erie. His work and that of his assistants helped make the meeting the success it was. He is also a member of AIEE, ASHVE, and PSPE.

Thomas Spring McEwan

Thomas S. McEwan, vice-president, Utility Survey Corporation, engineers and cost consultants, Chicago, Ill., is a management-engineering specialist. While resident counselor for Stevenson, Jordan, and Harrison, Mr. McEwan influenced decisions in important administrative, operating, and sales problems with leading manufacturers in New York, N. Y., and the Midwest. These problems involved profit control and over-all management of diversified industries. During World War II he was selected to set up and run the War Production Board in the 7th Federal Reserve District. *Newsweek* selected his office as the best run in the country. After returning to civilian work he took up his counseling work to industry. In his present affiliation he is responsible for the phase of work with manufacturers on economies to be effected in their use of fuel, electricity, water, and refrigerating facilities. Mr. McEwan was awarded the Key of Merit for excellence in industrial engineering for 1946. In his service to ASME, particularly as Manager, 1941–1944; Vice-President, 1944–1948, he gave unstintingly of his time to further the aims and ideals of the Society throughout the Midwest. He has contributed a number of magazine articles and is the author of several monographs on management; his chart, "Evaluating Your Management Effectiveness," is copyrighted.

Paul V. Miller

Paul V. Miller, manager since 1923 of the small tool and gage division, The Taft-Peirce Manufacturing Company, Woonsocket, R. I., has made substantial and far-reaching contributions in the field of standardization as well as important original contributions to gage and machine-tool designs. He designed and built one of the earliest of the thread-grinding machines in this country in which he pioneered the principle of table and saddle support on precision-steel balls traveling on hardened and ground ways. This principle was subsequently applied to surface grinders where he introduced the tilting spindle for undercut and shoulder grinding. He holds many patents on gages and surface-grinder improvements. From the time Mr. Miller attended the first meeting of the American Gage Design Committee in 1926 he has taken an active part in standardization and has assumed much of the major responsibility for developing the technical details of American Gage Design Standards. His leadership in standardization work in the Society is evident from the many committees to which he belongs—particularly the Standing Committee of B1, and the Standardization Committees. In addition to his activities in the ASME he belongs to several other engineering societies.

THE American Society of Refrigerating Engineers is currently sponsoring 18 research projects in 15 American engineering schools. Approximately 80 cents per member or five per cent of the Society's budget is regularly allocated for research purposes.

Projects are chosen on the basis of benefit of the results to the refrigeration industry.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Executive Engineer, MME, 41, married, unusual combination of design, development, research, and administrative experience in fields of light and heavy rotating machinery, auxiliaries, and plant engineering. Me-859.

Manufacturing Executive, 42, P.E. Aggressive, resourceful, and energetic general manager; successful industrial record in directing and co-ordinating all phases of manufacturing, planning, engineering, purchasing, production, sales, and industrial relations both domestic and abroad. Me-860.

Positions Available

Designer, mechanical graduate, experience covering special machinery in paper-conversion field, to design, lay out, and supervise construction of paper machinery for manufacture of envelopes, bags, cups, food containers. Salary open. Mo. Y-6140.

Draftsmen-Engineers, experienced in heating, plumbing, air conditioning, or electric layouts for work in consulting engineer's office in Washington, D. C., or Richmond, Va. Up to $6240. Y-6141.

Plant Manager, 35–50, manufacturing experience, to take responsibility for complete plant management. Should have refrigeration knowledge and background, although strong managerial ability and production and estimating knowledge are most important. $12,000–$15,000, including bonus participation. Va. Y-6157.

Industrial Engineers, two, to furnish industrial-engineering consultant services to maintenance operations, and conduct motion, time, process, and procedure studies within an organization. $5400–$6400. Ohio. Y-6158.

Methods Engineer, considerable experience in tooling and shop methods, particularly writing operation sheets, production planning, and sketching tools and fixtures. $5000–$6000. Northern N. J. Y-6169.

Automatic Machine Designers experienced in razor-blade grinding-machinery design preferred, but experience in machine design and on grinding machines and technique helpful. $6600–$7200. Conn. Y-6171.

Building Maintenance Engineer, 35–45, mechanical graduate, to take care of lighting, elevators, air conditioning, heating, office, and building alterations, etc. $6000–$6500. Hoboken, N. J. Y-6173.

Project Engineers for machine-design research, mechanical graduates, at least ten years' board experience, including a substantial amount of time on machine design incorporating a multiplicity of motions such as levers, cams, eccentrics, genevas, etc. Should be able to create a design plan for machine, equipment, or process including direction of research work, engineering work, and experimental testing work. $6000–$10,000, depending on experience. Pa. Y-6177.

Product Development Engineer, 30–40, to head department of product development. Should have executive ability to handle accounts, meet clients, and direct engineers, draftsmen, and modelmakers under him. Exceptional opportunity for work with consulting engineers. $10,000. New York, N. Y. Y-6179.

[1] All men listed hold some form of ASME membership.

Assistant to General Superintendent, mechanical, to co-ordinate all-mechanical work and inspection and changes, and supervise all mechanical installation by subcontractor, for large office building. $6000. Pa. Y-6189.

Chief Engineer, mechanical graduate, at least ten years' experience in design, layout, and plant engineering in rubber-products field, to take charge of engineering department including plant maintenance. $8000–$9000. N. J. Y-6195.

Engineers. (*a*) Production manager, mechanical engineer for manufacturers of electric clocks. Must have plant experience, preferably in the precision-instrument field. $15,000–$20,000. (*b*) Production manager with general engineering and textile-production experience, for bag and burlap company. Should have a good working knowledge of labor relations. $15,000 and up. New York, N. Y. Y-6198.

Plant Manager, preferably mechanical graduate, at least ten years' supervisory and managerial experience in textile, paper, or specialty-machinery fields, to take charge of mechanical equipment manufacturing plant. $8000–$10,000, bonus. Conn. Y-6219.

Chief Design Engineer, 32–43, mechanical graduate, preferably with experience in special machinery, wire drawing, and light metal work. $9000–$10,000. New York, N. Y. Y-6223.

Designer, mechanical engineer, at least eight years' experience in steam-station design and layout. Knowledge of powerhouse equipment. Will supervise engineering on steam power plants on high-pressure and high-temperature work. Company may help on fee. $8000–$10,000. Ala. T-8327(*a*).

Process Engineer, over 26, recent graduate or better on electromechanical work. Knowledge of layout of small assemblies. Duties will include production engineering, process control, some time study, and some estimating. Company will pay moving expenses and may help on fee. Up to $7280. New York, N. Y. T-8328(*b*).

Plant Engineer, 35–45, mechanical or electrical graduate, ten years' experience in plant engineering department. Will take charge of maintenance, power plant and buildings, and grounds. Will be in charge of pressure steam plant, 1200 hp. Company is planning to change to high-pressure system. Department has 45 employees including millwrights, carpenters, electricians, etc. Company will pay moving expenses. Up to $8000. Northern Ind. R-8291.

Chief Industrial Engineer, 35–45, industrial or mechanical graduate, five years' experience in industrial engineering, two of which have been in electronics field. Will take charge of industrial-engineering department of 20 working on processing, time standards, estimating, production, tool designing, work-simplification systems, control, and in general all-around work under direction of industrial-engineering department. Company will pay moving expenses. Up to $8500. Northern Ind. R-8293.

Designer, mechanical, over 40, ten years' experience designing high-speed automatic machinery. Knowledge of packing or paper-converting machinery. All board work designing automatic machinery. Company will pay fee. $7000–$8000. Ill. R-8298.

Project Engineer, up to 35, two years' or more experience in development work on domestic sheet-metal work. Knowledge of domestic driers. Will do project work on domestic driers. Company may help on fee. $6000–$7500. Minn. R-8331.

Tool and Processing Engineer, 35–45, mechanical experience in die design, metalworking machinery and processing, all types of welding, sheet-metal and bar stock. Will work in plant engineering department in semisupervisory capacity. Company will pay fee. $8000–$10,000 and bonus. Western Chicago suburb. R-8332.

Designer, mechanical engineer, 30–45, five years' experience in industrial furnace design, conveyers, and heavy equipment. Knowledge of heat-treating operations and some metallurgy. Informed about controls and instruments for gas and electric. Will design furnaces to customers' specifications and estimates. $6760. Ill. R-8358.

Assistant Plant Manager, 35–45, completely informed on high-production techniques, general machine-shop operations, and machining. Will supervise production, maintenance, and shop scheduling. $15,000–$18,000. Ind. R-8436.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Dec. 24, 1951, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

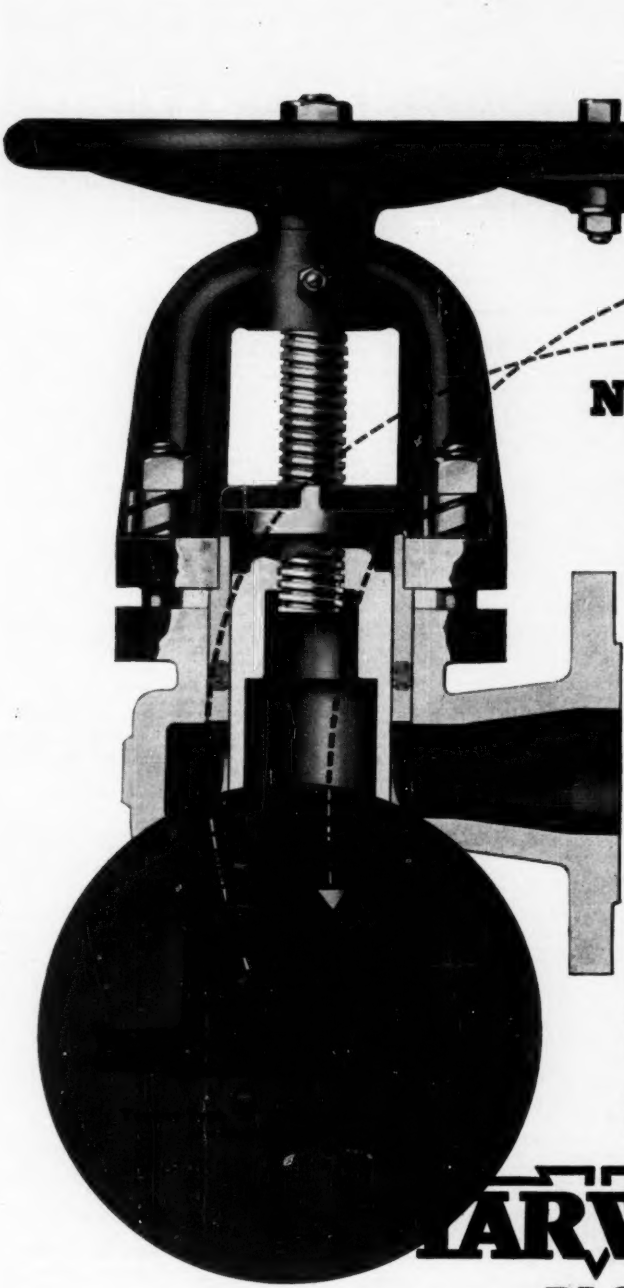
R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Addoms, James N., Arlington, Mass.
Aiello, Carmine P., Swarthmore, Pa.
Anne, John W., Jeannette, Pa. (Rt & T)
Araujo, Ariano, Baton Rouge, La.
Arnold, John E., Wenham, Mass.
Arnt, Chester J., Chicago, Ill.
Aspoas, A. R., Johannesburg, South Africa
Atchison, James L., N. Olmsted, Ohio
Atherton, Robert R., Drexel Hill, Pa.
Baker, David W., Hyattsville, Md.
Balder, J. Royal, Wilmington, Del.
Barkah, Karno, Los Angeles, Calif.
Beck, C. E., Park Ridge, Ill. (Rt & T)
Bencher, Walter S., New York, N. Y.
Benson, Jack, Detroit, Mich.
Berkowitz, Leonard K., Raynham Center, Mass.
Betts, Dennis R., Pelzer, S. C.
Blackman, Arthur W., Jr., Hartford, Conn.
Bostian, Ralph W., Spencer, N. C.
Bradford, Thomas C., Worcester, Mass.
Brosby, Harold T., Lancaster, Pa.
Bruckman, William C., Newton, Iowa
Carlson, C. B., Jr., Oakland, Calif.
Carlson, John G., Los Angeles, Calif.
Cohen, Gerald H., Rochester, N. Y.
Cole, Frank J., Montreal, Que., Can.
Collison, Harriet M., Mrs., Baltimore, Md.
Cooper, William D., Wilmington, Del.
Cowart, Eugene G., Tuscaloosa, Ala.
Danielson, Milton C., Denver, Colo. (Rt & T)
Darcy, Thomas F., New York, N. Y.
Darling, Paul R., Barrington, Ill. (Rt & T)
Davis, Jefferson W., Montgomery, Ala.
Demarest, D. M., New York, N. Y.
Deter, Eugene B., West Haven, Conn.
Dexter, William M., Knoxville, Tenn.
Dibble, G. T., Rochester, N. Y.
Draper, Eaton H., Albuquerque, N. Mex.
Elledge, Charles W., Coolidge, Ariz.
Faraci, Jean P., Wilmington, Del.
Farmer, William A., Elyria, Ohio
Farnsworth, Robert S., New York, N. Y.
Feoley, Charles R., Laureldale, Pa.
Ferguson, Grover W., Wantagh, N. Y.
Finger, Karl E., Wilmington, Del. (Rt)
Fisher, Bennett, Greenwich, Conn.
Fishman, Niel I., Hamden, Conn.
Fletcher, B. H., Toronto, Ont., Can.
Fordyce, Rex M., Houston, Texas

(*ASME News continued on page 1042*)



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Yarway Seatless Blow-Off Valves are available singly or in tandem combinations for all pressures up to 1500 psi. For higher pressures up to 2500 psi, specify Yarway Stellite-seat valves.

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STOP BLOW-DOWN TROUBLES—KEEP BOILERS ON THE

Fretts, Lawrence P., Brooklyn, N. Y.
Friedman, Joel, Jersey City, N. J.
Gallichotte, Vernon H., Palo Alto, Calif.
Gelb, John, Bristol, Conn.
Ghormley, Hugh M., New York, N. Y.
Gibson, Ronald F., Montreal, Que., Can.
Gunderson, Gunnar E., Cicero, Ill.
Hackstaff, Bruce W., Huntington, N. Y.
Hagar, William T., Boston, Mass.
Hagerman, H. A., Wilmington, Del.
Harrisberger, Edgar L., Salt Lake City, Utah
Hart, Robert C., Piney Flats, Tenn.
Hawkins, William L., Charlotte, N. C.
Henneman, Richard G., Rock Island, Ill.
Hicks, Carlton S., Arlington, Mass. (Rt & T)
Hoernbruch, Fred W., Jr., Merion Station, Pa.
Hotte, E. Roger, Mt. Vernon, N. Y.
Hunter, William D., Tullahoma, Tenn.
James, Charles D., Omaha, Neb.
Johns, Willard L., Wilmington, Del. (Rt & T)
Jones, William L., Jr., Spartanburg, S. C.
Jorgensen, Jorgen A., Massillon, Ohio
Kamber, Robert S., New York, N. Y.
Kidder, Charles C., Crannell, Calif.
Klann, Alvin R., Milwaukee, Wis.
Landeck, Richard W., Pisgah Forest, N. C.
Larty, John E., New York, N. Y.
Lechner, Thomas P., Dayton, Ohio
Lee, James H., Tulsa, Okla.
Lesko, Leslie, Cleveland, Ohio
Lockwood, H. J., Hartford, Conn.
Loughridge, L. T., Salt Lake City, Utah
Lowery, James C., Birmingham, Ala.
Lukas, Benjamin J., New York, N. Y.
Lyne, James G., Cornwall Bridge, Conn.
Matzke, W. W., Elmhurst, Ill.
Mauntel, C. I., Drexel Hill, Pa.
McCallum, Colin, Islington, Ont., Can.
McLean, J. O., Richmond, Va.
Mearns, William, 3rd, Maplewood, N. J.
Miron, James B., New York, N. Y.
Mittl, George A., Maplewood, N. J.
Mohnkern, Charles L., Oil City, Pa.
Murphey, Robert P., Alameda, Calif.
Murphy, James D., Framingham, Mass.
Murro, Haim, Jerusalem, Israel
Narayanamurthi, Raja G., Bangalore, India
Newman, Edward D., Shreveport, La.
Niewoehner, Richard W., Columbus, Ohio
O'Neill, B. P., Downingtown, Pa.
Osgood, Robert E., Jr., Spartanburg, S. C.
Pagels, Elmer N., Chicago, Ill.
Perna, Angelo J., Park Forest, Ill.
Philastre, A. L., Martinsville, Va.
Phillips, Aris, Menlo Park, Calif.
Pocha, D. M., Jubbulpore, India
Prescott, Ralph F., Danielson, Conn.
Rambo, W. H., Portland, Oregon
Rhodes, Joseph A., Birmingham, Ala.
Richards, Lester J., Midland, Mich.
Richards, Lucien M., Pittsburg, Calif.
Ruehrwein, Edward W., Oak Park, Ill.
Ryan, Allen L., Glendale, Calif.
St. Clair, David W., Rochester, N. Y. (Rt)
Selvin, Gerald J., Upton, N. Y.
Sharpless, Robert H., Port Neches, Texas
Sheehan, William C., New York, N. Y.
Shoemaker, Robert C., Garden City, N. Y.
Siegel, William A., Jr., Detroit, Mich.
Sine, Harold R., Milwaukee, Wis.
Smith, Charles T., Philadelphia, Pa.
Smith, John M., Richmond, Calif.
Soehrens, John B., Alhambra, Calif.
Solberg, Thorvald A., Washington, D. C.
Stewart, D. B., Freeport, N. Y.
Stokes, Stanley, University City, Mo.
Stump, John C., Oak Park, Ill.
Sullivan, Thomas A., Milwaukee, Wis.
Summers, Louis U., Jr., Dunbar, W. Va.
Sunnen, August, Jr., Wilmington, Del.
Thistle, Henry, Wakefield, Mass.
Timo, Dominic P., Swampscott, Mass.
Tripolszky, Andras, Cleveland, Ohio
Tucker, Norman E., Omaha, Neb.
Tulvananda, C. R., Harrison, N. J.
Vivien, J. N., Berea, Ohio
Wagner, Anthony, Cedar Falls, Iowa
Wagner, Herbert J., Chicago, Ill.
Wagner, Herbert L., Detroit, Mich.
Wakeford, Walter J., Richland, Wash.
White, H. Louis, Milwaukee, Wis.
Wiegmann, Edwin C., Philadelphia, Pa.
Wise, William R., Corning, N. Y.
Wolf, Philip C., Watertown, Mass.
Wolff, Peter, Philadelphia, Pa.
Zoellner, Nicolaus A. J., São Paulo, Brazil

CHANGE IN GRADING

Transfers to Member and Associate

Bartolero, Carlo, San Marino, Calif.
Brodersen, Edward M., Monterey Park, Calif.
Brunner, Jules B., Skokie, Ill.
Crossley, Walter C., Athens, Pa.
Fertig, Edward J., Pemaquid, Me.
Forssell, Alfred G., Baldwinsville, N. Y.
Forstall, Walton, Jr., Pittsburgh, Pa.
Frost, William G., La Grange Park, Ill.
Geitman, Russell J., Chicago, Ill.
Hoyle, Robert J., Jr., Syracuse, N. Y.
Hull, Edwin H., Scotia, N. Y.
Kaye, Joseph, Cambridge, Mass.
Keely, H. L., Pittsburgh, Pa.
Knight, William R., Cincinnati, Ohio
Lagergren, Jonas M., Scotia, N. Y.
Mac Leod, Alan S., New York, N. Y.
Maier, Harry L., Jr., Wilmington, Del.
McPherson, John A., Jr., Greenville, S. C.
Meyer, Harold F., Cairo, Egypt
Nalven, Robert M., New York, N. Y.
Nixon, James A., Los Angeles, Calif.
Nordin, Obert L., Houston, Texas
Norris, H. Lee, Jr., Bellaire, Texas
Roth, Robert W., Orinda, Calif.
Smith, Walter G., Durham, N. C.
Sper, H. A., Roosevelt, N. Y.
Taylor, B. W., Philadelphia, Pa.
Traczewski, G. J., Columbus, Ohio
Turner, W. W., Jr., Montclair, N. J.

Transfers from Student Member to Junior 100

Obituaries

Philip Hanson Bean (1891–1951)

Philip H. Bean, superintendent, Market Street Gas Works, Public Service Electric and Gas Co. of N. J., died May 31, 1951. Born, Saco, Me., Aug. 24, 1891. Parents, Joel and Ida Ellen (Hanson) Bean. Education, BSCE, University of Maine, 1914. Married Margaret Anne Beatty, 1917. Assoc-Mem. ASME, 1922; Mem. ASME, 1935. Survived by wife and son, Richard B., Roslindale, Mass.

Wilber Slater Beiser (1903–1951)

W. S. Beiser, district engineer, Layne-Atlantic Co., Savannah, Ga., died Aug. 11, 1951. Born, Hinckley, Ill., Oct. 17, 1903. Education, PhB, Lawrence College, 1927. Mem. ASME, 1949. Survived by wife.

Arthur M. Branch (1883–1951)

Arthur M. Branch, consulting engineer, St. Louis, Mo., died Aug. 3, 1951. Born, St. Louis, Mo., Feb. 27, 1883. Education, attended Washington University. Mem. ASME, 1925.

Holcombe James Brown (1879–1951)

Holcombe J. Brown, retired, owner of firm of H. J. Brown, consulting engineer, Boston, Mass., died May 24, 1951. Born, New York, N. Y., Dec. 20, 1879. Parents, Charles Burroughs and Ella (Wyman) Brown. Education, two years, Lawrence Scientific School, Harvard University. Married Marian Russell Prescott, 1905; children, Marie (deceased), Prescott H. Mem. ASME, 1916. Survived by wife and son; grandchild, Marcombe H. Brown.

William Phillips Caine (1870–1951)

William P. Caine, retired consultant on steam engineering, Bessemer, Ala., died July 25, 1951. Born, Dayton, Ohio, Nov., 3, 1870. Parents, Daniel James and Lida (Phillips) Caine. Education, graduate, Toledo (Ohio) High School; Scott Manual Training School, 1889. Married Maude Eliza Durand, 1893; children, Irving D., William P., Jr. Jun. ASME, 1899; Assoc. ASME, 1904; Mem. ASME, 1918. Served the Society as member, Nominating Committee, 1916; chairman, Birmingham Section, 1918–1919. Survived by wife and two sons.

William Albert Carlson (1890–1951)

William A. Carlson, superintendent of motive power, Erie Railroad Co., Cleveland, Ohio, died June 16, 1951. Born, Chicago, Ill., April 27, 1890. Parents, Albert F. and Anna (Lund) Carlson. Education, high-school graduate, 1906; special courses, Pennsylvania State College. Married Margaret Swanberg, 1915. Mem. ASME, 1946. Survived by wife and four children, William G., Robert G., Meadville, Pa.; Beverly, and Joy.

Frederick James Emeny (1872–1951)

Frederick J. Emeny, vice-president, Deming Co., Salem, Ohio, died Aug. 20, 1951. Born, Cordova, Ill., April 21, 1872. Parents, George James and Maria A. (Van Wagenen) Emeny. Education, ME, Cornell University, 1895. Married Elizabeth Miller Brooks, 1900; children, Brooks, Frederick L., George B. Married 2nd, Mary Taggart, 1924. Assoc. ASME, 1899; Mem. ASME, 1921. Survived by wife and three sons.

Joseph Leonard Ferguson (1896–1950)

Joseph L. Ferguson, plant engineer, Glamorgan Pipe and Foundry Co., Lynchburg, Va., died July 9, 1950. Born, Orme, Tenn., June 24, 1896. Parents, William Francis and Tennessee Ann (Thomas) Ferguson. Education, BSME, Virginia Polytechnic Institute, 1926. Married Dorothy Elizabeth Giessen, 1933. Mem. ASME, 1946. Survived by wife and two daughters, Nancy Jo and Ellen Elizabeth.

Robert Culbertson Hays Heck (1870–1951)

Robert C. H. Heck, professor emeritus, mechanical engineering, Rutgers University, died Sept. 22, 1951, in Middlesex General Hospital. Born, Heckton Mills, Pa., Oct. 30, 1870. Parents, John L. and Mary G. (Hays) Heck. Education, ME, Lehigh University, 1893. Married Anna Wilson, 1902. Received DE, Lehigh University, 1927. He was the author of several textbooks on steam engines and steam turbines. Mem. ASME, 1906; Fellow ASME, 1943. Survived by two daughers, Margaret W. and Mrs. Harold E. Green; a son, Robert C. H., Jr., and two brothers, Louis and Capt. Nicholas H. Heck, U.S.A., retired.

Edward Henry Hempel (1895–1951)

Edward H. Hempel, consulting industrial engineer, professor, Polytechnic Institute of Brooklyn; co-ordinator, Management Institute, New York University, died Sept. 15, 1951. Born, Iglau, Moravia, Nov. 7, 1895. Parents, Edward and Bertha (Schilff) Hempel. Education, BME, Berlin University, Germany, 1918; BA, MA, PhD, Dipl. Kfm, various European schools; MBA, DCS, New York University. Naturalized U. S. citizen, New York, N. Y., May 11, 1936. Married Luisa Friás, 1934. Mem. ASME, 1941. Served the Society as chairman, Small Plant Committee; research secretary, Management Division, 1939–1946; member, General Management Committee, 1939–1946. He was editor of "Small Plant Management," ASME-McGraw-Hill, 1950; author of several books and articles on management. Survived by wife.

William George Jackson (1890–1951)

William G. Jackson, engineer, authority on the treatment of steel and the conditioning of furnaces, died Aug. 19, 1951. Born, New York, N. Y., Oct. 7, 1890. Parents, William G. H. and Jane (Healy) Jackson. Education, ME, Stevens Institute of Technology, 1915. Married Blanche H. Henriksen, 1916. Mem. ASME, 1942. Survived by wife and daughter, Marion J. (Mrs. Walter E.) Mather, Arlington, Va., and three grandchildren.

Warren Tustin James (1921–1951)

Warren T. James, head of engineering personnel, Procter and Gamble Co., Cincinnati, Ohio, died July 8, 1951. Born, New Rochelle, N. Y., May 12, 1921. Parents, Harold Beals and Mary (Young) Beals. Education, BSME, Purdue University, 1948. Married Miss West, 1943. Jun. ASME, 1948. Survived by wife.

Paul Stuart Kennedy (1888–1951)

Paul S. Kennedy, vice-president, Murphy Paint Division, Interchemical Corp., Newark, N. J., died June 6, 1951. Born, Rockland, Me., Sept., 26, 1888. Parents, William F. and Clementine S. Kennedy. Education, BS, Worcester Polytechnic Institute, 1910. Married Eva McAfee, 1926. Mem. ASME, 1926. Survived by wife.

Friedrich Hugo Heinrich Kluge (1904–1951)

Friedrich H. H. Kluge, consulting engineer, Dressers Industries and Clark Brothers, Inc., Olean, N. Y., died July 11, 1951. Born, Schwarzenberg, Erzgebirge, Germany, June 24, 1904. Parents, Otto Hugo and Hildegard Louise (Haueisen) Kluge. Education, certificate of maturity, Technical Academy, Chemnitz, Germany, 1925; Dipl. Ing. ME, Technical University, Dresden, 1928; Dr. Ing. Applied Mechanics, 1930; Dr. Ing. Habil. Aachen, 1941. Married Dorothea Grun, 1935. He held several U. S. patents on centrifugal compressors and parts and was the author of about 25 papers published on the subject here and abroad. Mem. ASME, 1949. Survived by wife and three children, Ingrid M., Karin E., and Wolfgang F.

Daniel Kolb, Jr. (1926–1951)

Daniel Kolb, Jr., mechanical engineer, U. S. Corps of Engineers, Louisville (Ky.) District Office, died Aug. 17, 1951. Born, Louisville, Ky., Oct. 4, 1926. Parents, Daniel and Minnie (Bloat) Kolb. Education, BSME, University of Louisville, 1948. Married Jean E. Kraft, 1948. Jun. ASME, 1948. Survived by wife and daughter, Nancy Lee.

James Edward MacLaren (1897–1951)

James E. MacLaren, managing director, B.S.A. Tools, Ltd., Birmingham, England; Burton, Griffiths and Co., Ltd.; Index Automatic Machine Co., Ltd.; Leo C. Steinle, Ltd.; B. G. Machinery, Ltd.; Cardiff Foundry and Engineering Co., Ltd.; director, Birmingham Small Arms Co., Ltd., died Oct. 2, 1951, at his home in

(*ASME News continued on page 1044*)

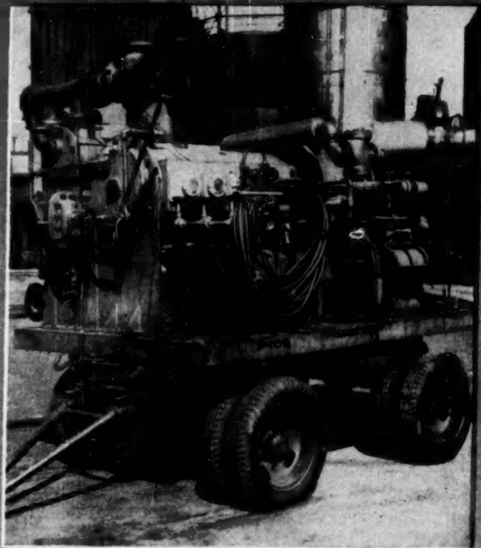
YOU CAN'T RISK NOW!

Today's urgent production demands can tolerate no unwarranted risk of interruption by explosions which might cause even small fires or other plant damage. Against such hazards, R-C Inert Gas Generators provide positive, economical protection.

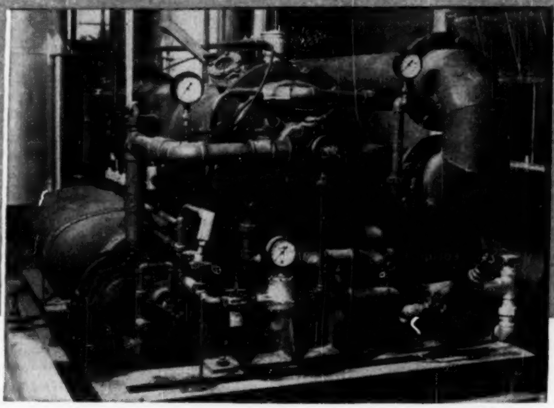
This protection is essential in plants where inflammable gases, liquids, explosive dusts and other dangerous materials are handled, processed or stored. Available either in stationary or mobile units, R-C Inert Gas Generators greatly reduce the risks from fires caused by explosions. They are compact, simple and sturdy in construction and operate at extremely low cost. Available in capacities from 1,000 to 35,000 cfh.

If your operations involve materials or processes which might cause explosion-produced fires, investigate the protection afforded by R-C Inert Gas Generators. Installation costs in many cases can be offset by insurance savings. Ask us for details.

Roots-Connersville Blower Corporation
510 Michigan Ave., Connersville, Indiana.



Portable R-C Inert Gas Generator used for purging operations and stand-by protection in large gas-producing plant. Capacity 15,000 cfh.



Installation of three R-C Inert Gas Generators similar to this one helped one large plant save $6,000 per month insurance premiums, as well as substantially reduce danger of production losses caused by explosion or fires. Capacity of each unit, 6,000 cfh.

ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

ONE OF THE DRESSER INDUSTRIES

Birmingham of a pulmonary embolism. Born, French River, Nova Scotia, Can., Nov. 4, 1897. Parents, Thomas Grant and Amelia (Finlayson) MacLaren. Education, graduate, Providence (R. I.) Technical High School; graduate apprentice, Brown and Sharpe Manufacturing Co., Providence, R. I. Married Miss Brodie, 1931. During World War II he was Regional Controller of Production in the Midland area. He served on various committees related to research in and development of the machine-tools industry and established valuable connections with many of the largest machine-tools undertakings in the United States. He belonged to many professional societies. Assoc-Mem. ASME, 1930; Mem. ASME, 1935. Survived by wife and two daughters, Shiela Mairi and Iona Catherine.

Patrick William McDonough (1888–1951)

P. W. McDonough, founder and president McDonough Steel Co., Oakland, Calif., died Aug. 24, 1951, in Wellington, New Zealand. Born, San Francisco, Calif., Feb. 20, 1888. Parents, Festus Michael and Anne (Joyce) McDonough. Education, LLB San Francisco Law School, 1917. Married Irene Costello, 1920; children, Monica Winifred and Eileen Mary. Assoc-Mem. ASME, 1921; Mem. ASME, 1931.

Henry C. Moffett (1886–1951)

Henry C. Moffett, chief engineer, Moffett and Troop, Inc., Pittsburgh, Pa., died Aug. 29, 1951, at his home in Dallas, Texas. Born, Minneapolis, Minn., June 22, 1886. Parents, William Z. and Berta (Lee) Moffett. Education, ME, Columbia University, 1912. Married Ruth Childs, 1914. Mem. ASME, 1921. Survived by wife.

Robert Carl Rahm (1870–1951)

Robert C. Rahm, retired designing engineer, Wyomissing, Pa., died May 29, 1951. Born, Hallau, Schaffhausen, Switzerland, Aug. 18, 1870. Parents, Johann J. and Elise (Auer) Rahm. Education, graduate, Technicum, Winterthur, Switzerland; ICS. Naturalized U. S. citizen, Reading, Pa., 1899. Married Minnie P. Hieter, 1901; children, Gertrude A., Carl J., Hans E. He held many patents on textile machinery. Mem. ASME, 1942. Survived by wife and three children.

Jules Henry Robert (1893–1951)

Jules H. Robert, professor of applied mechanics, Kansas State College of Agriculture and Applied Sciences, Manhattan, Kan., died July 2, 1951. Born, Lacon, Ill., April 13, 1893. Parents, Paul Henry and Louise Adele (Brandt) Robert. Education, BSME, University of Illinois, 1914. Jun. ASME, 1918. Survived by brother, John A. Robert, Birmingham, Ala.

Crawford Monroe Rosebrugh (1888–1951)

Crawford M. Rosebrugh, whose death was recently reported to the Society, was chief engineer, Houston Pipe Line Division, Gulf Oil Corp., Houston, Texas. Born, Chatham, Ont., Can., March 5, 1888. Parents, Daniel Wesley and Mary Alexine (Crawford) Rosebrugh. Education, BS, Olivet College, 1910; CE, ICS, 1917. Married Ruth E. Couch, 1914; children, Eugenia Mary, Crawford Thomas. Mem. ASME, 1929.

William Stewart Roth (1898–1951)

William S. Roth, mechanical engineer, Day and Zimmerman, Inc., Philadelphia, Pa., died Aug. 25, 1951. Born, Wilkes-Barre, Pa., April 19, 1898. Parents, John Lloyd and Ella (Hummel) Roth. Education, BS, Pennsylvania State College, 1920. Married Mary Mae Skelton, 1934. Mem. ASME, 1947. Survived by wife.

C. Payne Sheltman (1894–1951)

C. Payne Sheltman, chief engineer, Great Lakes Dredge and Dock Co., New York, N. Y., died May 30, 1951. Born, Crandall, Texas, June 19, 1894. Parents, William and Ruth (Sheltman) Sheltman. Education, high-school graduate, ICS; Polytechnic Institute of Brooklyn. Married Mildred V. Martin, 1931. Mem. ASME, 1947. Survived by wife and two daughters, Mrs. Pauline (Frank C.) Marciniak, South Plainfield, N. J.; Mrs. Mary Lou (Raymond V.) Glennon, Staten Island, N. Y.

Richard Stanley Vogt (1917–1951)

Richard S. Vogt, shop superintendent, Thomas C. Wilson, Inc., Long Island City, N. Y., died June 6, 1951. Born, New York, N. Y., Feb. 10, 1917. Parents, Joseph P. and Anne (Flemming) Vogt. Education, Bachelor of Aeronautical Engineering, New York University (Evening), 1943. Married Margaret Szego. Jun. ASME, 1943. Survived by wife and son, Douglas B.; father and two sisters, Eleanor Sandhowe and Hazel Robinson.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

Four weeks are required to complete master-file changes.

ASME Master-File Information

(Not for use of student members)

Please print **Check mailing address**

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Home address.. ☐
Street City Zone State

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Address of employer.. ☐
Street City Zone State

Product or service of company..

Title of position held..

Nature of work done..

Please register me in three Professional Divisions as follows:

1 ....

2 ....

3 ....

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I am a subscriber to (please check)

Transactions ☐ Journal of Applied Mechanics ☐ Applied Mechanics Reviews ☐

ASME to Cosponsor Midwest Fluid Mechanics Meeting

The American Society of Mechanical Engineers will be one of the sponsors of the Second Midwestern Conference on Fluid Mechanics to be held at The Ohio State University, Columbus, Ohio, March 17–19, 1952. Other sponsors include: The Graduate School of The Ohio State University, American Meteorological Society, Institute of Aeronautical Sciencies, the Fluid Dynamics Division of the American Physical Society, and the Columbus Sections of the American Institute of Chemical Engineers, and the American Society of Civil Engineers.

A broad range of subject matter concerning different phases of theoretical or applied fluid mechanics is planned for the conference. Among the subjects expected to be taken up are: Aerothermodynamics, applied mathematics, atmospheric flow patterns, combustion, compressible flow, convective heat, mass heat transfer, dynamics of interstellar matter, hydraulics, hydrodynamics, lubrication, magneto-hydrodynamics, mechanics of flow of particles (Aerosols, fluidized solids, smoke abatement, radioactive-waste disposal), turbulence, and viscous flow.

It is planned to publish proceedings of the conference.

YOU CAN ALWAYS trust R-C METERS

If you're measuring gas for production processes, you can't take any chances on quantities. If you are buying or selling it, you need cash register accuracy. You want equal precision for departmental cost accounting.

The permanent accuracy of R-C Positive Displacement Meters has long been proved for all these purposes by manufacturers and utilities which buy, sell and use gas. Four important reasons account for this unvarying reliability:

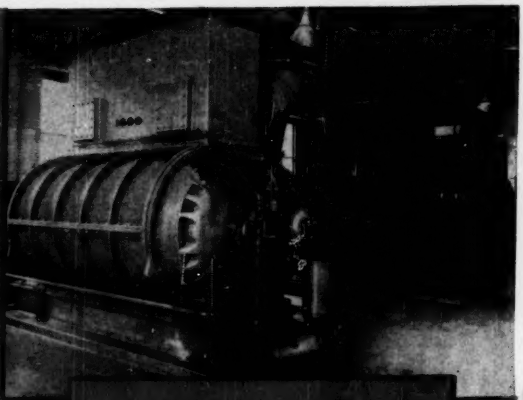
1. Accuracy is not affected by variations in specific gravity, rate of flow, pulsation, moisture, impurities or uncontrollable factors.

2. Accuracy is not subject to adjustment of meter or recorder by operators or other persons.

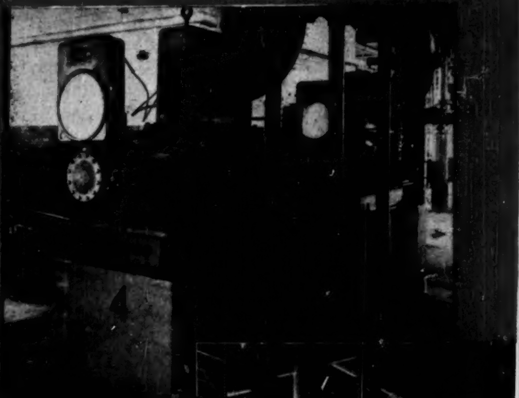
3. Accuracy is not affected by reasonable overloads.

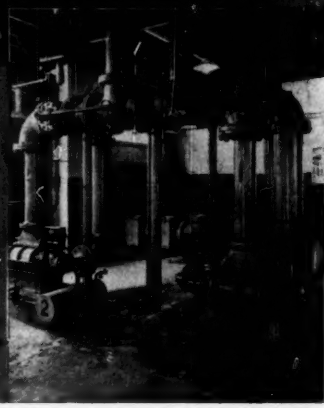
4. Accuracy is permanent because measuring chambers are surrounded by precision-machined, cast iron surfaces.

The 31 standard sizes of R-C Meters give capacities from 4,000 cfh to 1,000,000 cfh. They are extremely compact, permitting installation in cramped spaces. Indicating and recording instruments are available for all types. For whatever purposes you measure gas, you can permanently depend on R-C Meters. Ask for Bulletin 40-B-14 or write us your specific problem.



R-C Meter installation for large gas utility. [illegible], in front, has capacity of 1,000,000 cfh. Two older meters, in background, have been in use for years.





Part of an installation of nine R-C Meters in large processing plant, measuring acetylene gas sold to nearby manufacturers. They also use R-C Meters on receiving ends. Capacities range from 3,000 cfh to 132,000 cfh.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Michigan Ave.,
Connersville, Indiana

ROOTS-CONNERSVILLE

BLOWER BUILDERS R-C SINCE 1854

ONE OF THE DRESSER INDUSTRIES

DRAVO *Counterflo* HEATERS

have a certified High Standard of Safety!

LISTED UNDER REEXAMINATION SERVICE OF UNDERWRITERS' LABORATORIES, INC. — UL

ALL STANDARD MODELS, BOTH GAS-FIRED AND OIL-FIRED, LISTED BY UNDERWRITERS' LABORATORIES, INC.

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FM

ACCEPTANCE BY FACTORY MUTUAL ENGINEERING DIVISION OF DRAVO STANDARDIZED SAFETY CONTROL CIRCUIT.

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Because they have this safety approval, you'll find you can obtain the lowest-possible insurance rates with Dravo *Counterflo* Heaters. These savings represent only part of the many savings you get with Dravo warm-air heaters. For instance:

DRAVO HEATERS OFFER YOU . . .

- low initial cost . . . savings up to 60% on installation
- concentration of heat at working levels
- 150-foot air throw . . . no duct work required
- flexibility . . . units can be mounted in any position on floor, wall or ceiling
- automatic operation . . . on-off or modulating controls
- long service life . . . low maintenance . . . stainless steel combustion chamber eliminates refractory lining
- mobility . . . can be moved easily to any location
- low fuel consumption . . . direct-fired . . . burns gas or oil . . . readily converted

DRAVO HEATERS HAVE MANY USES . . .

These versatile heaters are ideal for commercial and industrial use in foundries . . . warehouses . . . machine shops . . . stores . . . schools . . . churches . . . process industries . . . and many others. Why not look into the possibilities of Dravo Heaters for your heating and ventilating needs? Write today for Bulletin No. QR-526-8

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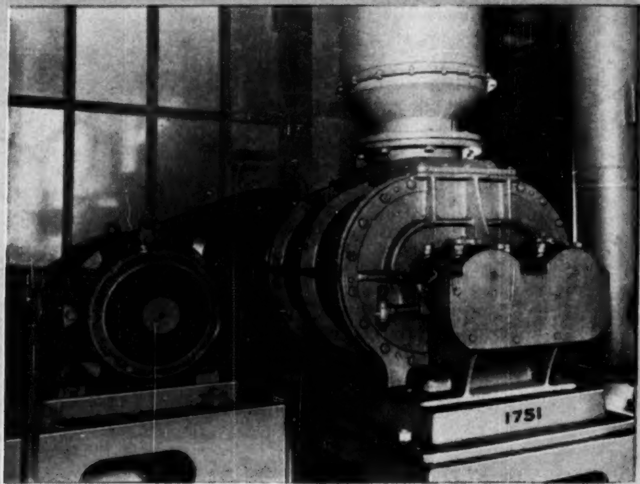
Manufactured and sold in Canada by Marine Industries, Ltd., Sorel, Quebec

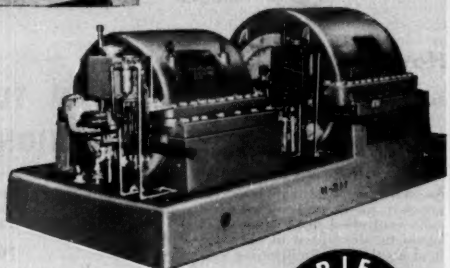
Export Associates: Lynch, Wilde & Co., Washington 9, D.C.

NO V-P-L WORRIES WITH R-C BLOWERS



ROTARY

Rotary Positive Blower for pneumatic conveying in large eastern processing plant. Many other R-C units are used in various plants of this same company.



Two, 4-Stage, Type H Centrifugal Compressors, mounted on common base. Motor driven, with capacities of 11,230 cfm and 8,990 cfm, respectively.

CENTRIFUGAL

Today's production urgencies call for "no-vacation" performance from blowers and other equipment to move gas and air. You must be sure of positive Volume, at the required Pressure, and at Low power cost to keep down rising expenses. The answer is Roots-Connersville Blowers with V-P-L.

You obtain this freedom from worry whether you install R-C Centrifugal or Rotary Positive equipment. This exclusive *dual-ability* gives you the choice of either type to best meet your requirements. Wide latitude in sizes, from 5 cfm to 100,000 cfm, permits selection of units with capacities close to your specific needs. Often, this flexibility saves time, cost, space, weight and power charges.

R-C engineers will gladly counsel with you on any problem of moving or measuring gas or air to keep production going.

Roots-Connersville Blower Corporation
510 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE

ONE OF THE DRESSER INDUSTRIES

JENKINS PRACTICAL PIPING LAYOUTS 58

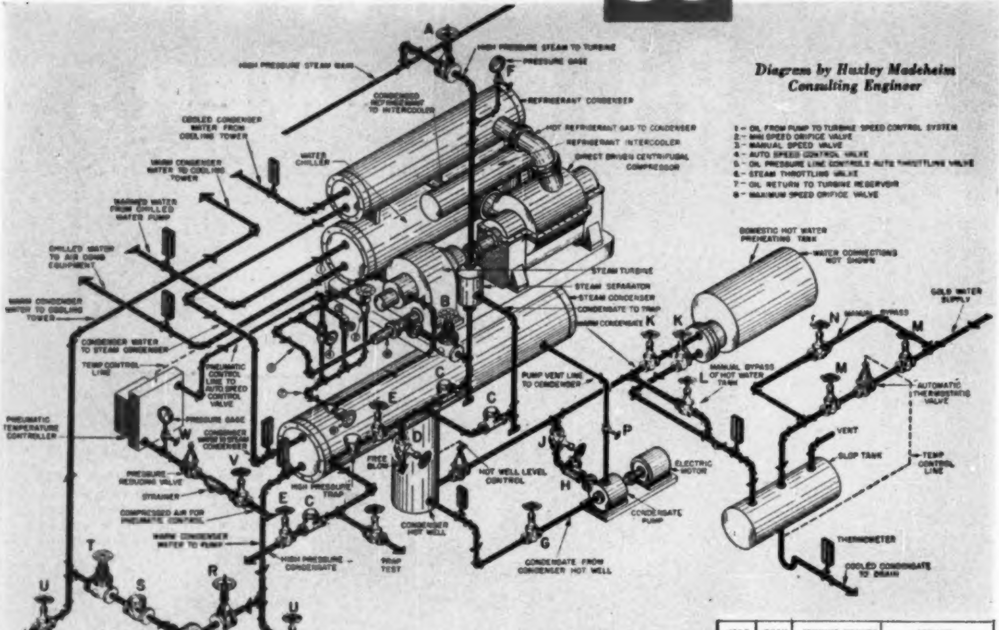


Diagram by Huxley Madeheim
Consulting Engineer

VALVE RECOMMENDATIONS

For details of valves to suit varying conditions, see Jenkins Catalog.

CODE	QUAN.	JENKINS VALVES	SERVICE
A	1	Fig. 204, I.B.B.M. Gate	Main Steam Supply Shutoff
B	1	Fig. 923, I.B.B.M. Globe	Steam Supply to Turbine
C	3	Fig. 962, Br. Swing Check	Prevent Condensate Backflow
D	2	Fig. 970, Br. Globe	Free Blow and Trap Test
E	2	Fig. 280, Br. Gate	Trap Shutoff
F	1	Fig. 703, Br. Needle	High Pressure Steam Gage
G	1	Fig. 370, Br. Gate	Condensate Pump Shutdown
H	1	Fig. 92, Br. Swing Check	Prevent Condensate Backflow
J	1	Fig. 106-A, Br. Globe	Condensate Pump Control & Shutoff
K	2	Fig. 370, Br. Gate	Preheat Water Tank Shutoffs
L	1	Fig. 106-A, Br. Globe	Preheat Tank By Pass
M	2	Fig. 370, Br. Gate	Cold Water Shutoff Valves
N	1	Fig. 106-A, Br. Globe	Manual By Pass
P	1	Fig. 741-G, Br. Needle	Condensate Vent
R	1	Fig. 253, I.B.B.M. Gate	Condensate Water Shutoff
S	1	Fig. 339, I.B.B.M. Swing Check	Condenser Water Pump
T	1	Fig. 162, I.B.B.M. Globe	Condenser Water Flow Control
U	2	Fig. 106-A, Br. Globe	Drain Valves
V	1	Fig. 106-A, Br. Globe	Prevent Air Supply Shutoff
W	1	Fig. 741-G, Br. Needle	Pressure Gage Control

How to plan

CONNECTIONS FOR STEAM TURBINE DRIVEN CENTRIFUGAL REFRIGERATION COMPRESSOR

As shown in the diagram, steam from high pressure mains passes through an automatically controlled steam throttling valve which varies turbine speed in accordance with the load on the air conditioning system.

Control is based upon the temperature of the chilled water leaving water chiller. A pneumatic controller, positioned by a temperature element in the chilled water discharge pipe, controls air pressure on a diaphragm valve in the oil pressure system.

This valve controls the pressure on the steam throttling valve, changing speed of the turbine in accordance with air conditioning load. Exhaust steam from turbine enters the steam condenser which maintains a very low back pressure (26" to 28" vacuum).

Where district steam is used, it is generally uneconomical to return the condensate to the boilers; condensate is merely discharged to the sewer after some of the heat has been used to preheat domestic hot water for the building. Local codes specify maximum heat of discharge.

Jenkins Valves listed are rated for an assumed high steam pressure of about 160 psi. and the condensing water pressure of about 200 psi.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installations.

TO SIMPLIFY PLANNING

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering, select all the valves you need from the Jenkins Catalog. It's your best assurance of lowest cost in the long run. Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros., Ltd., Montreal.

COMPLETE DESCRIPTION AND ENLARGED DIAGRAM OF THIS LAYOUT FREE ON REQUEST. Includes additional detailed information. Simply ask for Piping Layout No. 58.

JENKINS
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VALVES
SINCE 1864
TRADE JENKINS MARK

Jenkins Bros

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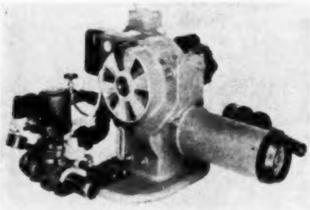
Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Combustion Oil-Gas Burner

Whenever gas is sold on interruptable or curtailable service, it necessitates a burner in which either gas or oil can be used. The Cleaver-Brooks Co., Milwaukee, Wis., has solved this problem with the introduction of its line of five "Hev-E" combination oil and gas burners.

Advantages of the new line of burners include a forced-air draft system which provides a single blower fan for all air for combustion, assuring perfect control to the fire under all atmospheric conditions. Both gas and air are accurately controlled to give high CO_2 with the greatest efficiency. And both oil and gas are burned efficiently.



The Hev-E burners can be regulated to burn the proper amount of gas or oil for the requirements of the particular installation. On all burners, low-fire start is accomplished with either gas or oil. On the two larger sizes, the AMG-5 and AMG-7, full modulation between high and low fire is available.

The most modern type of electronic controls are used to guarantee that the main gas valve cannot be opened unless a pilot flame is established. These same electronic controls are those fully developed, widely used, and proved superior in the burning of oil. Changeover from gas to oil on all models is quickly accomplished.

The models range from 720,000 maximum Btu gas burned in the AMG-2 size to 8,700,000 maximum Btu gas burned in the AMG-7 size.

Lightweight Man Trolley

A new lightweight man trolley is being designed and fabricated by Dravo Corp., Pittsburgh, Pa., for an existing ore-handling bridge at Granite City Steel Company's plant, Granite City, Ill.

The new trolley will operate with a 12-ton bucket and will replace the original trolley which was designed to handle a 7 1/2-ton bucket. Two new 600-series mill-type direct-current motors will power the trolley and two others will be used for bucket hoisting, holding, and closing drums.

Supercharged Generator

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has announced the installation of the world's first supercharged generator at the Edgewater plant of the Wisconsin Power and Light Company in Sheboygan, Wis. This new design rated 60,000-kw, 12,500-volt, 3600-rpm steam-turbine-driven generator was installed in midsummer and is now in operation. It embodies a new principle which saves 30 to 40 per cent of the material of a normal 60,000-kw machine.

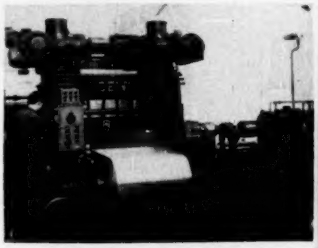
The great reduction in weight and length is achieved by forcing hydrogen at much higher velocity than has been used before, directly over the surfaces of the current-carrying copper conductors of the rotor. In addition to the normal fans for circulating the hydrogen, the new generator has a two-stage centrifugal compressor, much like an oversize aircraft supercharger, mounted at one end of the rotor shaft supplying gas to the rotor. To get the heat out of the rotor faster, engineers have devised specially shaped copper windings through which cool hydrogen travels at high speed. After being heated in passing through the rotor, hydrogen is cooled by conventional water-to-hydrogen heat exchangers.

The heat-removing ability of the supercharged design is demonstrated by test data showing that in less than 1/60 sec hydrogen passes through the full length of the rotor passages of a 60,000-kw machine, while at the same time it absorbs enough heat to raise the temperature to 90 F.

In addition to the great savings in copper and steel effected by the new design, several other important advantages are brought about. Powerhouses of the future will be smaller and less costly, resulting from the shorter rotor and reduced rotor removal space required. Foundations will be simpler and reduced in size. Short-circuit currents are substantially reduced, with consequent savings in cost of circuit breakers, reactors, and other equipment and with less damage likely to occur in event of short circuit.

Cold Rolling Mills

The Loewy Rolling Mill Division of Hydropress, Inc., New York, N. Y., recently put in operation two high-speed installations for the cold rolling of aluminum foil, 42 in. wide × 0.00025 in. thick. Each of these installations is composed of one four-high roughing mill, 10 in. and 24 in. × 48 in., and one two-high finishing mill, 18 × 48 in., with their accessories. These mills, capable of producing foil at speeds up to 3000 fpm, and provided with modern mechanical and electrical equipment to assure accurate control of gage and trouble-free operation, may be operated with a minimum of skilled personnel.



A pushbutton station, located close to the mill on the delivery side, permits the operator to closely observe the product he is rolling; from here he also controls the screwdowns, either in unison or separately, the front and back tension, as well as the speed of rolling according to the thickness of the material leaving the mill, as indicated by his electric gage.

The coils, weighing up to 3000 lb, are wound on cores which are interchangeable throughout the equipment in the plant. They are loaded on the winding or unwinding reels by means of carriages controlled by the operator from the pushbutton station. The unwinding reels are provided with a special device for axial movement of the drum to permit the operator to correct any telescoping in the coil.

Chain Vise

Disassembling, repairing, or connecting roller chain is now extremely simplified by the use of the new Baldwin-Rex chain vise, recently announced by Baldwin-Duckworth division of Chain Belt Co., Springfield and Worcester, Mass. The vise makes it possible to take apart single or multiple strand roller chain in a few minutes with ease.

The vise is made of forged steel for long wear, with hardened jaws specially shaped for adapting to various chain sizes. Approximate adjustments are made before the chain is inserted, permitting rapid clamping. It is made in two sizes; No. 1, for single-strand roller chains from 1/2 through 1 in. pitch, for double-pitch chains of 1, 1 1/4, and 1 1/2 in. pitch, and for double-strand chains of 1/2, 5/8, and 3/4 in. pitch. Vise No. 2 is intended for single-strand chains of 1 through 2 in. pitch and for double-strand chains from 1 to 2 in. pitch.

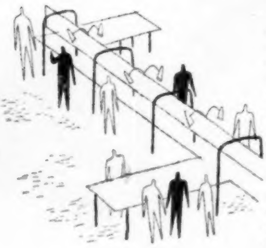
Continued on Page 45

the truth about Dow Corning Silicones...

. . . is more fantastic than the patter of the pitchman or the spiel of the barkers that doubled in advertising and sales a generation ago. For example:

- Silicone (Class H) electrical insulation makes motors and other kinds of electrical equipment last 10 times as long as they ever did before.
- These same insulating materials are used to double the power per pound ratio in electric machines.
- Silastic,* the Dow Corning silicone rubber is used to seal hot air at 600°F., hot oil at 350-400°F., limit switches and bomb bay doors at −100°F.
- Dow Corning Silicone oils and greases make permanent lubrication a practical reality.

To many engineers and executives, such silicone facts as these still sound too good to be true. That's why we have built and assembled 16,000 pounds of demonstration units and typical applications to prove that our silicone products will do all that we claim for them. This is the first comprehensive Silicone Exposition ever assembled. Previewed in Washington, D. C. during the week of October 22nd, this exhibit will be given private showings in major industrial centers across the country.



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now scheduled for

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If you want to know more about this Exposition write for complete information including our new 32-page book which answers in simple words and pictures, the $64 question, **"What's a Silicone?" Address Department Q-12**

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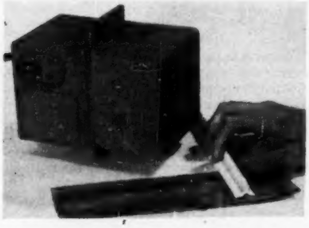
• Keep Informed

Miniature Oscillograph

Up to nine sources of data representing vibration, pressure, velocity, strain, or other phenomena, either static or dynamic, can record simultaneously on the new $5 \times 5 \times 8$-in. recording oscillograph, type 5-118, just released by Consolidated Engineering Corp. of Pasadena, Calif.

Operating from a 28-volt d-c power source, this highly compact test instrument is ideally suited to mobile testing programs, where space and weightsaving are of paramount importance and yet highly accurate results are required.



Developed originally for a missile-testing program, this midget oscillograph produces dynamic test records 3½ in. wide and up to 40 ft long on which the nine separate phenomena can be measured with respect to both time and one another.

The new oscillograph employs the same standard type 7-200 galvanometers as used in the larger Consolidated oscillographs (Types 5-114 and 5-116). The galvanometers are mounted in a stable, cast magnet block to insure uniform, dependable results and are easily reached for adjustment or replacement when the film magazine is removed. A translucent cover on the galvanometer opening hinges back to become a graduated screen for vertical and horizontal adjustment of light spots. Tools for galvanometer adjustment are conveniently stored in the magazine.

Carboloy Broadens Activities

A vast broadening of the sphere of its activities was revealed by Carboloy Dept. of General Electric Co., recently.

While retaining its position as the world's largest producer of cemented tungsten carbide, the Carboloy organization is engaged in developing a wide variety of new products and metallurgical materials.

In general, the Carboloy organization divides its products into four groups:

1 Established products. This group already includes tungsten carbide, permanent magnet metals, and Hevimet.

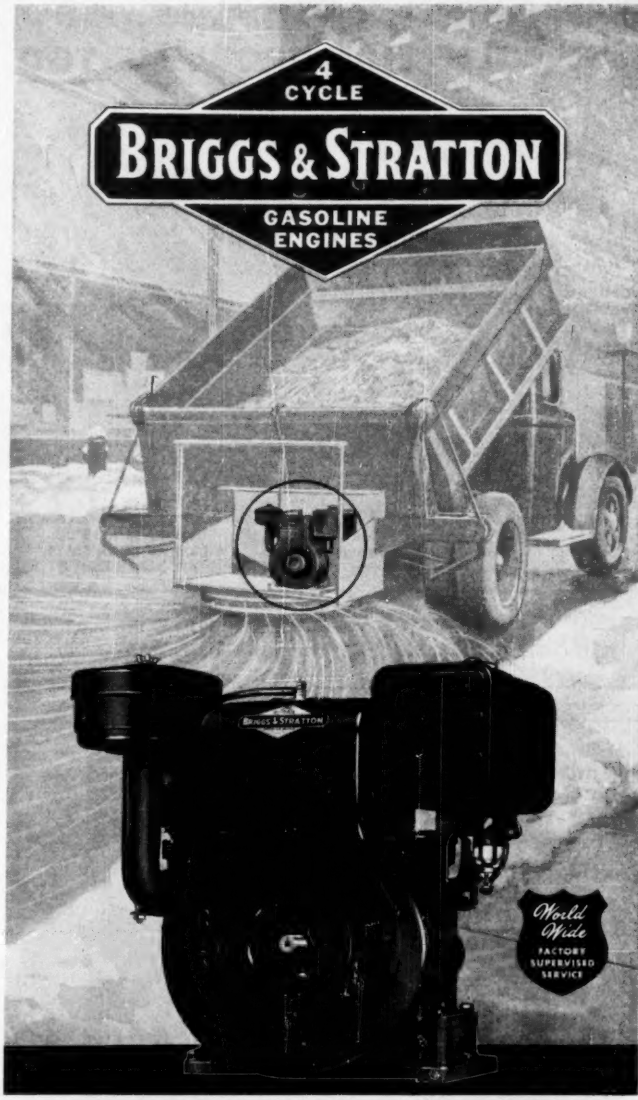
2 Products which have been field tested in pilot-plant production and for which quantity output is planned. In this group are the new chrome-carbide metals characterized by extremely high resistance to all forms of wear—abrasion, corrosion, and erosion, as well as resistance to oxidation at high temperatures. These metals require no strategic tungsten or cobalt.

3 Products which are out of the laboratory stage and in the "engineering appraisal" stage. In this group, the following are included: (a) bearing metals, (b) titanium carbide, (c) thermistors, (d) cemented carbide "welding" rod.

4 Products still in the Research Laboratory stage.

In its oldest field—tungsten carbide—Carboloy revealed a number of promising advances.

Continued on Page 46



Preferred power for sand and material spreaders and a wide range of other equipment for road maintenance and construction — the world's most widely used single-cylinder gasoline engine on machines, tools, appliances used by industry, railroads, oil-fields, and on equipment for farm and home.

BRIGGS & STRATTON is the world's largest builder — more than 30 years of continuous production — of single-cylinder, 4-cycle, air-cooled gasoline engines. Briggs & Stratton Corporation, Milwaukee 1, Wisconsin, U.S.A.

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

All These Were Once
DUST COLLECTION PROBLEMS, TOO

48 Carbon Black Plants
203 Metallurgical Installations
205 Acid Plants • 40 Paper Mills
270 Detarring Installations
216 Power Stations
73 Steel Plants • 99 Oil Refineries
and Miscellaneous Installations

Your electrical precipitator installation will be individually engineered...and based on the Research Corporation's *experience* graphically shown by that towering pile of thousands of blue prints.

This knowledge is a valuable asset that will help Research engineers to "tailor-make" your Cottrell installation. For example, they can more quickly determine the right answers to such variables as the size, shape and type of both discharge and collecting electrodes, their relative spacing, flue arrangements and many other factors. At Research you can count on *profitable solutions to individual problems.*

Research Corporation Cottrells can be made as efficient as you desire. They can collect 95% to over 99% of all solid or liquid particles suspended in gas entering equipment. Write for free booklet giving valuable data.

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• 6 TONS OF SODA SALTS AT PAPER MILL

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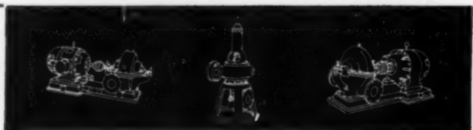

Small Capacity • Medium Duty
SIDE SUCTION PUMPS

Close-Coupled • Flexible Coupling • Belt Drive

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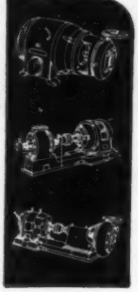
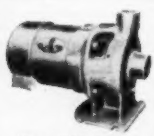
5 to 75 G.P.M.

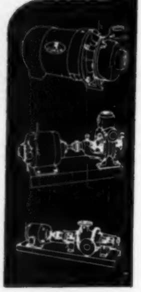
HEADS
0 to 100 ft.



Ideal as part of Equipment Manufacturer's product, such as, air conditioning units, cooling towers, evaporator coolers, milk coolers, hot water circulators, etc. — and general service. Speeds 1750 to 3500 R.P.M.



Type JMC Aurora Close-Coupled Pump



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AURORA Always PUMPS

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Among those of particular interest are the following:

1 Cold extrusion. Action development of tooling for this process, which allows metals to be formed into varied shapes with a minimum of machining.

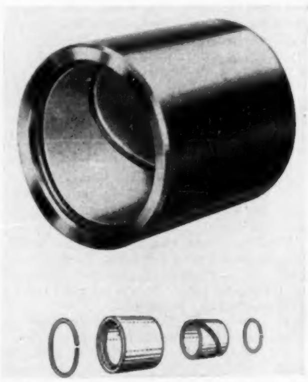
2 Hot-formed carbide rings. Solid carbide rings formed by bending hard carbide rods to shape.

3 Wear-resistant parts. Hammermill blades, for instance, which simplify mill design and reduce maintenance requirements.

4 Mining drills. Now produced by industry in a wide variety and in sizes up to 7 in. in diam.

Nylon Bearings

To overcome several limitations which restrict the suitability of plain injection-molded or machined Nylon bearings for many applications, Thomson Industries, Inc., Manhasset, N. Y., has developed the NYLINED Bearing. A typical NYLINED Bearing, as illustrated, consists of an outer sleeve of inexpensive metal and a relatively thin lining of Nylon bearing material. The Nylon liner is retained in the outer sleeve in a manner which will permit it to expand and contract circumferentially around the inner periphery of the outer sleeve. The liner is provided with a narrow slot, or compensation gap, which interrupts the circumference. In applications where lubricants can be used, one or more annular grooves are provided on the inside of the outer sleeve to form storage wells for grease or other lubricants which are evenly distributed through the compensation gap.



The NYLINED principle eliminates the need for wide clearances which are necessary in plain Nylon bearings to compensate for dimensional changes due to thermal expansion and moisture absorption. Dimensional changes in the NYLINED liner are taken up by the compensation gap with no appreciable effect on the diameter.

NYLINED Bearings present no cold flow or creep problem which makes it inadvisable to press fit plain Nylon bearings, hence they can be inexpensively and rapidly installed by press fit or clamping methods.

There is no danger of seizure due to stress deformation which can distort the bore of most plastic-type bearings. Internal stresses in the thin section liner are negligible, and any slight tendency to change is taken up in the compensation gap.

NYLINED Bearings can be furnished in the plain sleeve type or the flange type.

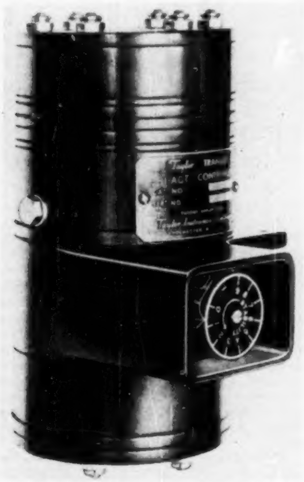
• Keep Informed

When substantial thrust loads must be carried in addition to radial loads, the bearing is usually laid out to provide a separate surface of Nylon bearing material to take the thrust. Since NYLINED Bearings can be quickly fabricated to special dimensions without expensive or elaborate molds or dies, they can be furnished on a custom basis, designed expressly for each application, rapidly and economically.

Force-Balance Controller

A new nonindicating, force-balance controller with only one-knob adjustment for two control responses has been recently introduced by the Taylor Instrument Companies, Rochester, N. Y.

The Transet* Bi-Act* controller, as it is called, is designed for applications where it is desirable to transmit the measured variable to some remote location. It is particularly adaptable to flow, liquid level, or pressure applications requiring fast reset rates and broad throttling bands, or applications where derivative action is not essential.



The Bi-Act controller incorporates several features which make it especially advantageous to many applications: (1) A new and simplified control circuit which pneumatically links proportional and automatic reset responses together. (2) One knob to adjust both proportional and automatic reset responses so that the processes can be brought to a stable condition with extreme ease. (3) Controller action can be changed quickly and easily without disturbing any piping connections. (4) An optional, plug-in-type, leakless manifold provides a simple means for connecting or removing controller. (5) Rapid controller action is obtained by a large-capacity booster air relay. (6) Built-in cut-off relay is provided on all Bi-Act controllers so that they may be either panel or field mounted. (7) An inexpensive controller for those applications where derivative response is not required.

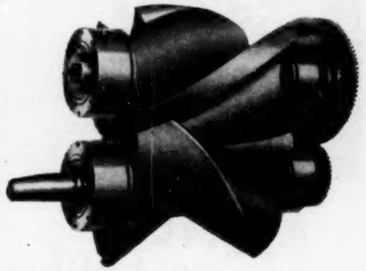
The controller measures only $7^1/_2$ in. overall length and has a range of adjustment of 1 to 200 per cent throttling range and automatic reset of 0 to 100 repeats per minute. Write for bulletin No. 98070, Taylor Instrument Companies, Rochester, N. Y.

Continued on Page 48

The STANDARDAIRE PRECISION BUILT *Axial Flow* BLOWER

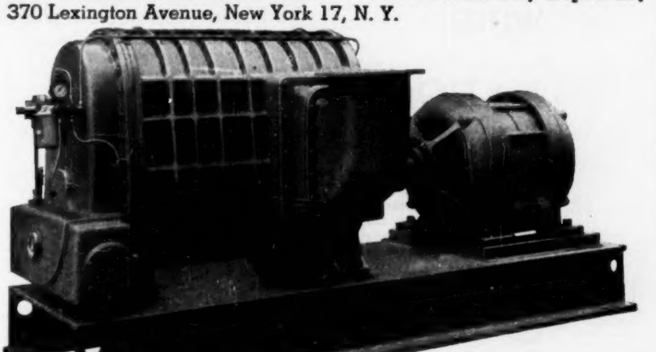
Features Two More Vital Components:

PRECISION ROLLER BEARINGS—spherical type are used on the fixed ends of the rotor shafts and a cylindrical type on the floating ends. With such a design free aligning action of the rotor shafts is assured and specific speed, load, and service requirements are easily met. In addition, this bearing construction fully compensates for any housing distortion which might occur due to temperature differentials.



LABYRINTH TYPE OIL SEALS—Bearings and gears are lubricated by a spray of filtered oil. The oil is controlled by a balanced pressure, labyrinth type seal which gives complete oil control and assures absolutely clean air delivery under all operating conditions.

Such features as precision bearings—frictionless oil seals—hardened, shaved, helical gears—contribute immeasurably to the efficient and dependable performance of the Standardaire Blower—A Modern Machine with Superior Operating Characteristics. For further information write READ STANDARD CORPORATION, Dept. E-20, 370 Lexington Avenue, New York 17, N. Y.



Standardaire Blower No. 105B21 and motor, mounted on common base, for direct drive through flexible coupling to deliver 3200 c. f. m. at 1750 r. p. m.

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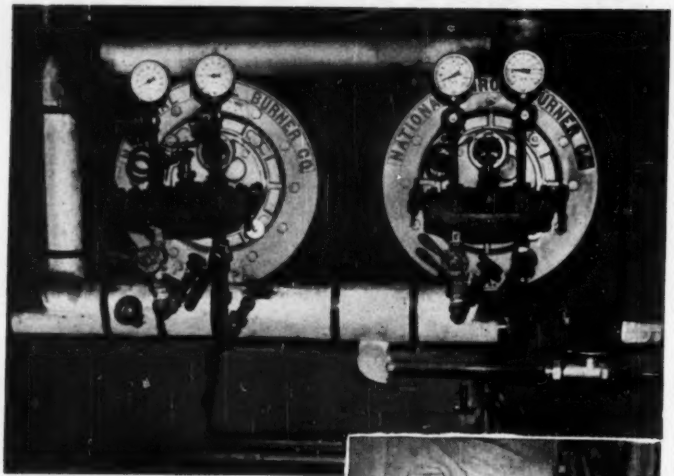

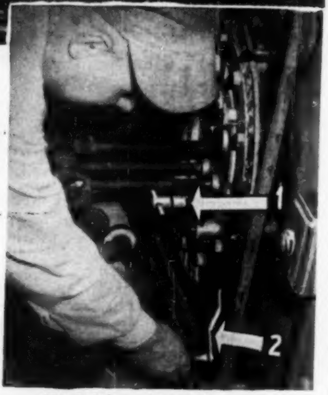

(1) Refractory Faced Disk Control
(2) Air Vane Control

BETTER PERFORMANCE

...DUAL CONTROL

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You get better performance with NATIONAL AIROIL Universal Registers because they have a dual feature for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disk. Both adjustments can be made while the burner is firing.

NATIONAL AIROIL Universal Registers are equipped for dual fuel firing of gas and oil.

Universal Registers with burners are manufactured in three sizes with capacities up to 60,000 lbs. of steam produced per burner per hour.

Write for information on your business letterhead.

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OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

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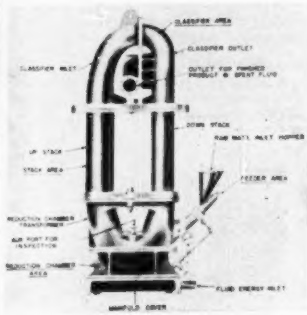
• Keep Informed

Fine-Particle Reduction Mills

Wheeler fine-particle reduction mills, sometimes referred to as fluid energy mills, are now available for purchase outright. Formerly these mills were leased on a rental basis.

Made by C. H. Wheeler Mfg. Co., Philadelphia, Pa., the fine particle reduction mill is based on the principle of fluid energy attrition. Raw material of minus 4 mesh or smaller is introduced continuously into the inlet hopper. An injector feeds the material from the hopper into the reduction chamber, pressurized fluid, air, steam, or any gas or vapor, enters the manifold and is discharged



through suitable nozzles into the reduction chamber at sonic or supersonic velocities. Feed material is entrained by the stream of circulating gas. The violent jet action in the reduction chamber breaks up the individual particles by impact and abrasion against each other. As particles are whirled around and around in the mill they reduce each other in the reduction chamber area. Centrifugal force shifts the larger particles toward the outer periphery. The smaller particles work toward the inside as they are reduced to desired submicron size. They escape with spent fluid through the classifier outlet into Wheeler centrifugal type collectors.

The mill is presently available in two sizes. Model 0405 is the small mill for 200 to 1800 lb feed rate per hr. Model 0808 is the large mill for 400 to 6500 lb feed rate per hr. The large mill produces $2^1/_2$ times more than the small mill, using air—and $3^1/_4$ to 4 times more, using steam—estimated on the basis of the same power consumption for both mills. Production per ton is correspondingly cheaper where the large mill capacity can be used.

Vane-Type Rotary Pump

A heavy-duty vane-type rotary pump has been added to the existing line of rotary pumps manufactured by Worthington Pump and Machinery Corp., Harrison, N. J.

All models are positive displacement, sliding-vane type in which the pressure of the liquid being pumped maintains contact of the vanes against the liner.

The pumps are to be manufactured in both internal and external bearing design; the external bearing models being especially suited for nonlubricating liquids such as gasoline and kerosene. The pumps are manufactured with built-in relief valve and can be manufactured in either standard-fitted, bronze-fitted, or in all-bronze construction.

• Keep Informed

High-Speed Hoist

A new high-speed mine hoist will help boost the production of defense-vital iron ore at the Alan Wood Steel Company's Scrub Oaks Mine in Dover, N. J.

The hoist, driven by a 1750-hp General Electric d-c motor, is designed to lift 250 tons of iron ore up a 3840-ft shaft every hour. Operating at a rope speed of 2315 fpm, the hoist will deliver a nine-tone load to the surface every two minutes.

Installation of the new hoist is part of a program to boost production of crude ore from the mine—New Jersey's largest—to about 2000 tons every eight working hours. The ore, after concentration, is used by the Alan Wood Company in the production of high-grade steel.

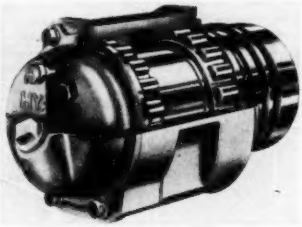
Constructed by the Nordberg Manufacturing Co. of Milwaukee, Wis., the new hoist will utilize two buckets or "skips," each having a nine-ton capacity.

In addition to the 1750-hp, amplidyne-controlled, adjustable voltage drive, General Electric will supply a 1500-kva, three-phase transformer, a motor-generator set, switchgear, and controls.

Roller Bearing Journal Boxes

The trend toward equipping all types of railroad cars with roller bearing journal boxes has been given added impetus by the introduction of a new line of roller bearing journal boxes for freight cars, by Hyatt Bearings Division of General Motors Corp., Harrison, N. J.

These new boxes have been designed to fit conventional freight-car trucks with both the integral-box-type and pedestal-type side frames. They can be installed to replace existing plain bearing equipment, with only a minimum of alteration to the truck side frames.



Hyatt journal boxes for freight cars are grease lubricated. The bearings are of the straight radial type giving maximum load-carrying capacity in the space provided. Thrust loads are taken against liberally proportioned race flanges. Straight radial construction of the bearings permit car axles to float laterally within predetermined limits thus cushioning sidewise shocks and reducing wheel flange wear.

All bearing and box parts are completely accessible for cleaning and inspection. Both journal boxes and bearings can be removed from car axles without breaking race fits. Spare wheel and axle sets can be stored with only inner races, spacer and thrust rings in place instead of complete journal boxes thus reducing spare parts inventories.

The housings for integral box type side frames are designed in such a way that they can be reversed top to bottom to present a new wear surface in the bearing load zone thus lengthening the usable life of the unit.

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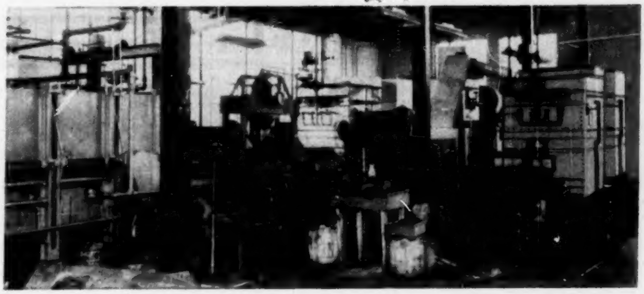


Niagara Aero Heat Exchanger quickly pulls down the initial peak load of heat in quenching . . . and saves cooling water

Accurate control of quench bath temperatures and quickly effective capacity to handle the initial peak load of heat in quenching prevents production set-backs, increases the output of your heat treating department, prevents oil fires, saves you losses from rejected parts.

Niagara Aero Heat Exchangers give you this control in both furnace and induction hardening methods. They prevent both over-heating and over-cooling of the quench bath. Hundreds of heat treaters know they prevent many troubles, constantly improve quality and increase production.

They quickly pay for themselves by saving cooling water coils and extend your quench capacity without extra water or cooling tower.

Write for Bulletin #120 giving complete information.

NIAGARA BLOWER COMPANY

Over 35 Years' Service in Industrial Air Engineering

Dept. ME, 405 Lexington Ave. New York 17, N. Y.

Experienced District Engineers in all Principal Cities

No Frost Spray Cooler

Niagara Blower Co., New York, N. Y., announces an improved model No Frost spray cooler applying to the refrigeration and refrigerated storage of products that are sensitive to the moisture content of the air, especially foods which are liable to dry out, shrink, or discolor in cold dry air. The equipment differs from previous models in that the air enters through the fans and is blown through the units. The air passes over refrigeration coils and through a spray of No Frost liquid solution which prevents the condensation of water and the formation of ice or frost on the coils. The chilled air, which may be as low as —20 F passes direct from the spray chamber into the room, thus it contains no reheat from the energy of the fans and, therefore, higher humidity air is made available. With no loss of cooling capacity from accumulation of frost on the refrigerating coils, no interruption for defrosting and no reheat added to the air, closer control of conditions is obtained with resulting improvement in the quality of products held in refrigerated storage. This has been found valuable in the storage of eggs and other perishables.

Blueprint Reproduction

A new photographic reproduction paper which produces black-on-white photographic intermediates directly from blueprints and other negative originals without the need for darkroom handling or special reproduction equipment has been announced by the Eastman Kodak Co., Rochester, N. Y.

The new paper, named Kodagraph Repro-Negative Paper, can be exposed on standard drawing reproduction equipment, in ordinary room light, and processed with standard photographic chemicals. It is similar to Kodagraph Autopositive Paper, Kodak's direct-to-positive printing drawing reproduction material. Used as a companion material for Autopositive, it is stated, Kodagraph Repro-Negative Paper now makes it possible for a reproduction department or shop to standardize on positive photographic intermediates in its quantity-print production, regardless of the type of originals available.

The new paper is a silver-sensitized, medium-high-contrast material which is similar to conventional photographic papers in that it prints a positive from a negative and vice versa. However, since no darkroom handling is required and no special equipment is necessary, it is expected that it will fit in readily with the practices of most reproduction departments and shops.

Kodagraph Repro-Negative Paper can be used to reproduce just about any type of negative line original—old or new, in good condition or poor, the Company announces.

Magnetic Amplifier Regulator

A magnetic amplifier regulator has been tested on full-scale steel-mill equipment at the East Pittsburgh plant of Westinghouse Electric Corp. Tested under simulated operating conditions, it has successfully controlled a 4000-hp double-armature motor that will be used on a 66-in. tandem cold reduction mill.

Since the magnetic amplifier, physically and electrically, is a special form of the transformer, it is a static device—it just "sits" there. It is rugged, it has no bearings or brushes to maintain, it has no moving parts, and it can be mounted on panels in control cabinets so that no extra floor space is required. The magnetic amplifier requires no warm-up time as do electronic tubes, and it does not have the power limitations of tubes.

The operation of the magnetic amplifier is analagous to that of the three-element vacuum tube. In simple form it consists of two sets of coils wound on a magnetic core: one coil carries alternating current; the other carries direct current. The d-c winding corresponds to the control grid in a vacuum tube. Magnetically, a small variation in the current flowing in the d-c winding causes a large change in the reactance of the a-c winding, and hence a large change in a-c current flowing through this winding. Rectified by dry-type rectifiers, this energy can be used to perform control functions.

Selfocus Cathode-Ray Tube

A new selfocus cathode-ray tube for military applications has been developed by the Cathode-ray Tube Division of Allen B. Du Mont Laboratories, Inc., Clifton, N. J. This new tube results in better performance, simplification of the design of the equipment, and considerable saving in weight. It has been found that the Selfocus type of tube will save at least three pounds of weight in air-borne radar equipment.

The principle of selfocus permits, for the first time, the use of the cathode-ray tube which requires no focusing controls, no focusing coils, no permanent magnet focusing, or electrostatic focusing devices. Such a tube has long been the goal of all the manufacturers of cathode-ray tubes and has been cited by leading engineers as being the ideal tube, but something that could not be achieved in production. However, this tube is now being produced in large quantities by Du Mont.

When the selfocus tube is employed in a television receiver or a radar unit, the picture is always in perfect focus with no focus adjustments of any kind, regardless of line voltage variations or differences in brightness and contrast settings.

The selfocus principle can be used in nearly any size cathode-ray tube and is presently being incorporated in 17-in., 20-in., and 21-in. Du Mont Teletrons. Undoubtedly, many tube types designed specifically for military applications will employ the selfocus principle in the near future.

65,000-Hp Synchronous Motors

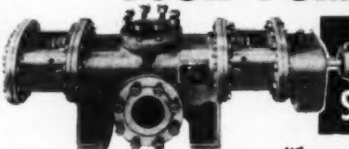
Two 65,000-hp synchronous motors, second to none in power and size, have been installed in the pumping plant at Grand Coulee Dam by engineers of the General Electric Co. in co-operation with the U. S. Bureau of Reclamation.

The huge motors, each weighing more than 330 tons, will be used in the Bureau's Columbia Basin Irrigation Project, under a program designed to help irrigate a vast expanse of rich but dry land in south-central Washington.

Built by the G-E Large Motor and Generator Divisions at Schenectady, N. Y., the motors stand 25 ft high and measure 100 ft around the base.

They will drive two of the world's largest pumps, each capable of supplying enough water to equal the daily requirements of the City of New York. When operating under optimum conditions, each pump will supply more than 1 billion gpd of water (50 tons a sec) to help transform the locality into a highly productive farming area, according to Bureau officials.

DOUBLE THE VALUE OF YOUR PUMP DOLLARS!



Specify *Sier-Bath* SCREW PUMPS

• Pump Shown: new External Gear & Bearing Bracket Type for non-lubricating fluids, semi-fluids. Capacities 1-700 GPM: Discharge 1000 PSI for viscous liquids, 500 PSI for water.

When you choose a Sier-Bath Screw Pump your total investment is about the same—but you get a pump worth *twice as much*:

Investment "A" TYPICAL	CHOICE *Investment "B"*
Cam, Lobe, Vane or Gear Pump.................$ 770.00	Sier-Bath Screw Pump...........$1570.00
Low Speed Motor (or high speed motor plus reduction gearing).............. 2580.00	High Speed Motor.............. 1860.00
TOTAL.......................$3350.00	TOTAL.......................$3430.00

Sier-Bath Screw Pumps are more dependable, need less maintenance, and last longer than the types listed in "A". Because their *axial flow* allows low liquid velocities with higher RPM, they use less expensive (and easier to get) high speed motors. As these motors provide service equal to that of low speed motors—and as Sier-Bath Screw Pumps provide *superior* service—"B" is the right choice.

For further information, see your local Sier-Bath Representative, or write to

Sier-Bath GEAR and PUMP CO., Inc.

9270 HUDSON BLVD., NORTH BERGEN, N. J.

Also Manufacturers of Gearex Pumps, Precision Gears and Flexible Gear Couplings

THOMAS

Flexible ALL METAL

COUPLINGS

FOR POWER TRANSMISSION
REQUIRE NO MAINTENANCE

Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

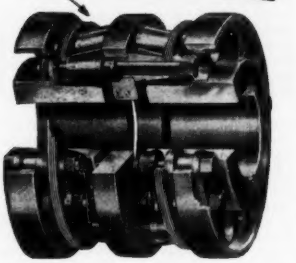
Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years

BACKLASH FRICTION WEAR and CROSS-PULL are eliminated

Lubrication is not required!

PATENTED FLEXIBLE DISCS



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.

NO MAINTENANCE PROBLEMS.

ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

• Keep Informed

Steam Cost Calculator

A new and modernized slide-rule-type calculator designed to provide a ready means of computing steam costs has been made available by the Cleaver-Brooks Co., Milwaukee, Wis.

The calculator, in handy pocket size, is available without cost to engineers, plant executives, and those who will find it useful in their work. The calculator enables the user to compute the comparative steam costs per 1000 lb using coal, oil, or gas—based on fuel costs of price per ton, price per gallon, and price per cu ft.

The users of the steam cost calculator can easily determine the costs of operating a Cleaver-Brooks steam boiler as compared with other types of oil-, gas-, or coal-fired equipment.

On the reverse side of the calculator is an easy-to-use slide indicating Cleaver-Brooks boiler horsepower, lb of steam per hr, output in Btu. EDR steam in sq ft (gross), EDR steam in sq ft (net), oil consumption per hr, and gas consumption per hr.

Such terms as boiler horsepower, therms, EDR steam, etc. are also defined. Various grades of oil and Btu gas are also defined.

High-Temperature Insulation

Johns-Manville, New York, N. Y., is now offering "Quinterra Type 3," an asbestos-base, silicone-treated, high-temperature electrical insulation. It is a Class H insulation, as defined by AIEE standards, for service at a temperature of 180 C.

Silicone-treated Quinterra Type 3 is used for both interlayer and wire wrapping insulation. It is adaptable to a wide range of electrical devices including air-cooled, inert-gas, and silicone-filled transformers. Some of the advantages it offers are savings on materials, a greater factor of safety, and the opportunity for more compact design.

Quinterra Type 3 is supplied in the form of sheets, rolls, and tapes. Widths can vary from $^1/_4$ to 36 in. and will be factory cut to specification. Available thicknesses are from 3 to 9 mils.

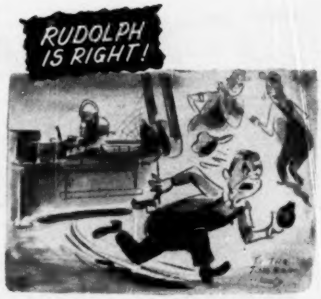
Temperature Regulator

An expansion-stem-type regulator used to maintain liquids or air at any temperature desired by controlling pneumatic or water-operated diaphragm valves or dampers has been announced by Powers Regulator Co., Skokie, Ill. Its applications include instantaneous water heaters, heat exchangers, large-capacity water-storage heaters, jacket water for air compressors, Diesel and gas engines, vats, dryers, dyeing and bleaching machines, dry bulb and dew point control.

Its simple rugged construction withstands vibration and insures many years of reliable service. Has adjustable sensitivity and overheat protection, calibrated dial temperature adjustment, temperature ranges 50 to 250 F and 150 to 350 F, easy to install at point where temperature is to be controlled, requires compressed air or water at 15 lb pressure. Small size regulator head is $2^7/_8 \times 3^3/_8$ in., sensitive bulb is 12 in. long with $^1/_2$ in. I.P.S. connection. Sensitive element: Invar rod enclosed by a silver-soldered copper bulb. Bulb wells of corrosion-resistant metals available.

Continued on Page 52

JANUARY 2-31
GIVE *Voluntarily* TO
MARCH OF DIMES



"Using the Right Cutting Fluid Would Eliminate a Lot of Time and Money Wasted Changing Cutters"

There are literally thousands of examples to prove how the right application of the *right* cutting fluid can make a tremendous difference in machining efficiency. Here is another one which will help you realize the opportunities afforded by an open-minded look at your cutting fluids:

• **THE JOB**: Generator machining a 1" dia. worm gear, double thread.

COMPARISON OF CUTTING FLUID PERFORMANCE

	Previous Oil	Stuart's THREDKUT
Production per grind/dress	20 pieces average	190 pieces average
Finish	Passable	Satisfactory
Oil dilution	None	4 to 1
Cost of oil on machine	42c/ gal.	27.2c/gal.
Downtime during test	2½ hours	None

Think of the increase in cutter life (cost about $86.90 each). Before using Stuart's ThredKut they were reground 9½ times as often. Add to this the saving in downtime and the saving in cutting fluid price and you'll see why "Rudolph is Right."

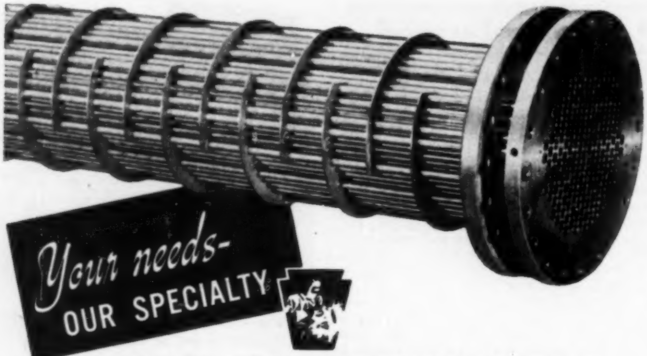
Write for your copy of Stuart's Shop Notebook—a bi-monthly publication devoted to the selection and application of metal-working lubricants.

GET MORE PRODUCTION
Use The Right Cutting Fluid

STUART SERVICE
Goes with every Barrel
Offices in Principal Industrial Centers

D.A. Stuart Oil CO.

2741 S. Troy St., Chicago 23, Ill.



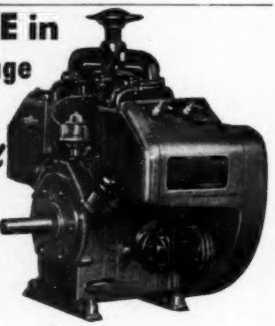
This condenser is 16" DIA. × 12' tube length; Bundle ¾" O.D. type 316 Stainless tubes-Double tube sheet also of type 316 . . . manufactured by the Heat Transfer Division of DOWNINGTOWN IRON WORKS, INC. DOWNINGTOWN solicits your inquiry for heavy duty shell and tube equipment fabricated of Aluminum, Inconel, Nickel, Phosphor Bronze, Copper, Silicon Bronze and various grades of Carbon Steel. Some of these are welded by the Inert-Gas-Metal-Arc method. DOWNINGTOWN is experienced in building equipment with Bi-metallic, Finned Tube and Impregnated Graphite.
Design and construction meet requirements of ASME Code or other agency specified by customer. Equipment of our design is sold on a guaranteed performance basis or we will fabricate to customer's drawings. Modern facilities available for radiographing where required. *Remember: "Your Needs are Our Specialty!"*

Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

DOWNINGTOWN IRON WORKS, INC.
DOWNINGTOWN, PA.
STEEL & ALLOY PLATE FABRICATION
HEAT EXCHANGERS

NEW YORK OFFICE, 30 CHURCH STREET

POWER ADVANTAGE in the Top Bracket Power Range . . . V-Type 4-Cylinder WISCONSIN *Air-Cooled* ENGINES, 15 to 30 hp.



These 4-cylinder, V-type Wisconsin Engines meet every heavy-duty power requirement. V-type design assures not only the smoothest power delivery but also represents substantial reductions in engine weight as well as extreme compactness . . . at no sacrifice of rugged construction.

CONDENSED SPECIFICATIONS

MODELS		VE4	VF4	VP4D
Bore	inches	3	3¼	3½
Stroke	inches	3¼	3¼	4
Displ. cubic inches		91.9	107.7	154
H.P. and R.P.M. range		15 at 1600	17.5 at 1600	26.8 at 1600
		21.5 at 2400	25 at 2400	31 at 2200
Net weight in lbs., Standard Engine		295	295	410

Our engineering department will gladly cooperate with you in adapting Wisconsin Engines to your requirements. Write for detailed data and the name of the nearest Wisconsin distributor.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

• Keep Informed

Constant-Support Hanger

A new Constant-Support hanger, Model L, providing simplified field adjustment, increased travel range, and greater load capacity with a smaller number of springs and fewer chassis sizes is now available from Grinnell Co., Inc., Providence, R. I.

The function of a constant-support hanger, to provide equal lift in all positions of travel of a piping system as it moves from expansion or contraction between its hot and cold positions, is performed more perfectly with the new Model L. A hanger structure designed for center support which places equal dimensions on each side of the center supporting line, nonresonance in its springing system, and provision to give less horizontal shift of the load line as the load shifts from cold to hot positions are three new refinements incorporated in the new design. Maximum travel with constant support has been increased from its former 4 in. to 5 in. in the medium chassis and from 8 to 10 in. in the large chassis.

Utility Pump

A completely submersible utility pump is now available from Kenco, Inc., Lorain, Ohio. Principal uses of this pump include the many types of sumps found in factory layouts such as in boiler room pits, underground utility installations, elevator pits, and other low areas. In addition to sump usage, this portable compact pump has many utility purposes such as draining flooded areas and buildings, pumping out new excavations for buildings and ditches, and draining tanks and vats.

In sump usage, since the pump is submersible, the entire portable unit can be installed right in the sump in a few minutes rather than having the motor on top of the sump supported by a permanent mounting. The motor is hermetically sealed in oil, requiring no oiling or greasing. Maintenance is eliminated.

This pump is also ideal for utility purposes since it weighs only 50 lb and can be moved and placed in operation quickly. It is compact, measuring 9½ in. high and a maximum diameter of 13 in. The pump is made of all bronze. Despite its small size, it has a capacity of 3300 gph.

• Keep Informed

Self-Priming Motor Pump

Ingersoll-Rand Co., New York, N. Y., has introduced a new line of self-priming motor pumps. These pumps are intended for pumping applications under suction lift where the presence of air or vapor makes it impractical to use the conventional centrifugal pumps. The pumps are used in process and bulk station applications, for mine drainage, bilge pumping, sump draining, and irrigation service.

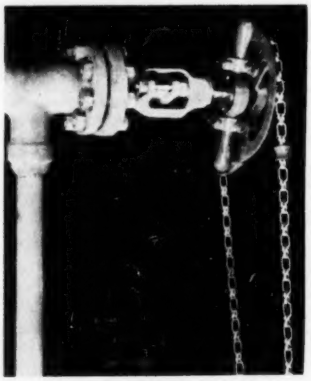
The pump is built in sizes from $^1/_4$ to 25 hp, with capacities up to 800 gpm and a head up to 180 ft.

Standard models of the self-priming pump utilize cast-iron casings with bronze impeller and are driven by NEMA motors supplied by well-known manufacturers. These pumps are also available mounted on ball-bearing equipped cradles to be driven through a coupling by a motor, engine, or turbine.

Impactor Handle

The problem of trying to close small valves tightly, especially when they're located from 10 to 50 ft above floor level can be remedied with a new impactor handle introduced by Edward Valves, Inc., East Chicago, Ind.

Of improved design, the impactor handle delivers 2.8 times the force of conventional handwheels.



It is designed so that the lugs on the underside of the handle strike simultaneous blows against the lugs of an adaptor securely attached to the valve stem. The simultaneous blows prevent stem twist and distortion which would result if the adaptor lugs were struck independently.

The handle is available with two adaptors of different size square openings to fit most standard size stems of various small valve makes. Sizes of the square openings, which taper towards the top, are $^{13}/_{16}$ and $^{15}/_{16}$ in. with total taper equal to $^3/_4$ in. per ft.

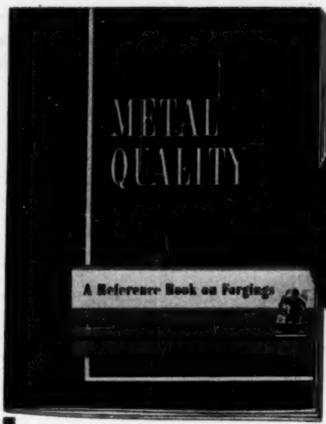
Centrifugal Fan

A new centrifugal fan arrangement, with weatherproof hood over the motor drive section that can be installed outdoors without further protective enclosure, has been announced by the Trane Co., La Crosse, Wis.

This fan is available with wheel diameters as large as 60 in., in backwardly inclined and forwardly curved, single width, single inlet models in Class I construction.

Designated as Trane Arrangement No. 10, the fan has high-efficiency, low-noise, and low-horsepower characteristics.

Continued on Page 54



Engineering, production and economic advantages obtainable with forgings are presented in this Reference Book on forgings. Write for a copy.

Forgings fortify a mechanism with a factor of greater safety that is otherwise unobtainable . . . There is no substitute for the toughness and strength inherent in the compact, fiber-like flow line structure of closed die forgings. Consult a Forging Engineer about the correct combination of mechanical properties which forgings can provide for your product.

DROP FORGING ASSOCIATION
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Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal", 1949 Edition.

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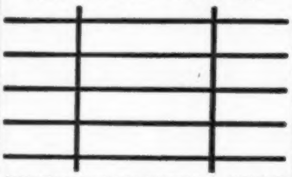
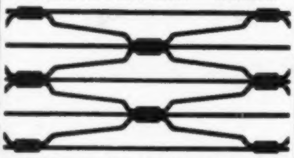
ALL TYPES — ALL SIZES



RECTANGULAR MESH — ABOVE or RETICULINE MESH — BELOW



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ECONOMICAL

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ESTABLISHED 1902
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LONG ISLAND CITY 1, NEW YORK
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OAKLAND 21, CALIFORNIA

• Keep Informed . . .

Electric Heating Element

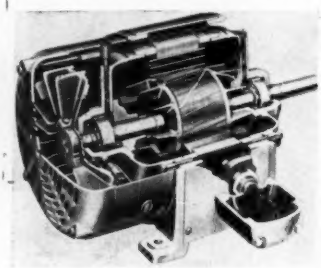
Syntron Co., Homer City, Pa., announces the manufacture of a new, flat, sheathed electric heating element, for industrial heating such as is used with kettles, tanks, ovens, dies, driers, and for immersion in liquids.

This new type unit provides flat surfaces for contact heating and a thin section for convection and air flow. It is a rugged structure, readily bent and formed and is resistant to moisture and vibration.

The $^{5}/_{16}$-in-thick flat surfaces promote efficient radiation effects. They can be supplied with self-regulating characteristics where their wattage will vary inversely with the heater temperature.

Explosion-Proof Motor

A 10-feature totally enclosed motor for explosion-proof requirements has been developed by U. S. Electrical Motors, Los Angeles, Calif. Made in capacities from 3 to 75 hp, this new motor, Types SE and SES, carries the Underwriters' label in Class 1, Group D, for highly inflammable gases and volatile liquids, and in Class 11, Groups F and G, for combustible dusts. Other types



SD and SS without label, for nonexplosion-proof services, are also available. Features incorporated include: Sealed terminal, elongated spark-arresting bearing sleeves, streamlined housing, hi-draft ventilation, removable cover, split hub fan, normalized castings, Lubriflush bearings, asbestos-protected windings, and solid, centricast rotor. Being completely sealed, this motor gives protection against external hazards, preventing intrusion of abrasives, acids, moisture, and other deleterious substances. A new bulletin, No. 1629, describes the motors.

Magnetic Rubber

The Brush Development Co., Cleveland, Ohio, has announced a new magnetic re-recording rubber made from a special neoprene base. The highly efficient magnetic oxide has been pigmented into the neoprene with an unusually good degree of uniformity. Included in the base material is a permanent lubricant which virtually eliminates wear of both medium and associated recording head. Mechanical compliance of the medium provides for intimate contact with the recording head.

These recording bands have been primarily designed for use when stretched over a supporting drum. They can be supplied on special order in various sizes and shapes to meet your requirements.

This development was initiated by and carried out in close co-operation with the Bell Telephone Laboratories Inc.

Step-Motor Impulse Counter

A newly designed step-motor impulse counter to provide one hundred per cent accuracy up to 60 counts per second, has been announced by the Special Products Division of the General Electric Co.

Designed to cover counting ranges above those possible with electromechanical counters and below those in which scalers are normally required, the device has a counting range which makes it especially useful in high-speed production counting. According to the engineers, it may be used in such applications as counting the number of vitamin pills produced by a factory or counting flaws in fabric at process speed.

The counter, it is said, will also be used in certain types of radiation counting where the use of a direct-reading register is desirable.

The step-motor impulse counter consists of a step motor with a resetting type register and a power supply enclosed in a steel case. The step motor and register assembly are mounted on the power supply enclosure, which contains an electronic switch and a high-voltage supply capable of supplying the power requirements of a photo tube preamplifier.

The counting assembly can be easily removed and placed in a remote position such as a control panel.

This impulse counter is rated at 0.60 counts per sec. But, according to the G-E engineers, the two-phase step motor provides a high degree of accuracy even at counting rates in excess of 100 counts per sec.

Additional information on the step-motor impulse counter is contained in publication GEC-829 which is available from the General Electric Co., Schenectady 5, N. Y.

Centrifugal Ammonia Compressor

The first large centrifugal ammonia compressor ever installed in this country, to be used for process refrigeration at the Monsanto Chemical Co. plant, Nitro, W. Va., was announced by Carrier Corp., Syracuse, N. Y.

A five-stage centrifugal compressor driven by a 600-hp motor has been scheduled for installation in the Monsanto plant to double the capacity of an existing reciprocating ammonia system.

The new unit will serve as the low-stage compressor in the Monsanto refrigeration plant, taking the ammonia gas at 25 lb suction pressure and discharging it to the high stage at 75 lb. Addition of the centrifugal unit will increase system capacity from 400 to 800 tons.

The compressor will be of all ferrous construction for use with ammonia, and will be similar to those used for some years for air and gas compression in the petroleum and chemical processing industries.

New Gas Clipper

Easier accessibility to the engine compartment, a new type parking brake, an instrument panel mounted on the steering column, easier steering, and redesign for faster maintenance are features of the improved Clark gas clipper, announced by Industrial Truck Division of Clark Equipment Co., Battle Creek, Mich.

To remove the hood and seat to get to the engine, it is necessary only to remove the radiator cap and air breather cap. For access to the engine for simple adjustments, etc., louvers on both sides hinge at the bottom and fold down to expose the engine compartment.

• Keep Informed

"No-Kick-Back" steering is achieved by the use of an Elliot-type axle with the tie rods in the same plane and more nearly in line with the forces they transmit, plus relocation of steering knuckles as close to the tire's dead-center shock point as is practical.

A "quick-change" clutch has been adapted to minimize "down time" if changing of clutch becomes necessary. Unscrewing two bolts and disengaging the accelerator pedal allows fast accessibility to the clutch housing.

Quik-Lok Clamp

A new accessory for Di-Acro benders known as the Quik-Lok clamp, is being offered by O'Neill-Irwin Mfg. Co., Lake City, Minn.

The Di-Acro Quik-Lok clamp is available for all No. 2 and No. 3 Di-Acro benders now in use, and it can be readily mounted by merely bolting it onto the bender base.

This quick-acting clamp is ideal for use when bending tubing, angle, channel, and extrusions as it securely locks these materials during the forming operation thereby assuring a perfect bend and its wide opening jaws allow easy removal of the formed part.

It will accommodate all materials within the capacity range of Di-Acro benders and can be readily adjusted for any radius to 9 in.

Complete information covering this product and also a complete new line of tube bending accessories for all Di-Acro benders is contained in a new Di-Acro bending manual entitled "It's Easy to Bend."

Oil Switch

A new single-pole oil switch, the type CSO-1, is available from the Westinghouse Electric Corp., Pittsburgh, Pa. Developed primarily for control of small banks of pole-mounted capacitors, the switch is well-suited for sports field lighting, street lighting, airport lighting, and as a load break sectionalizing switch on rural and suburban distribution systems.

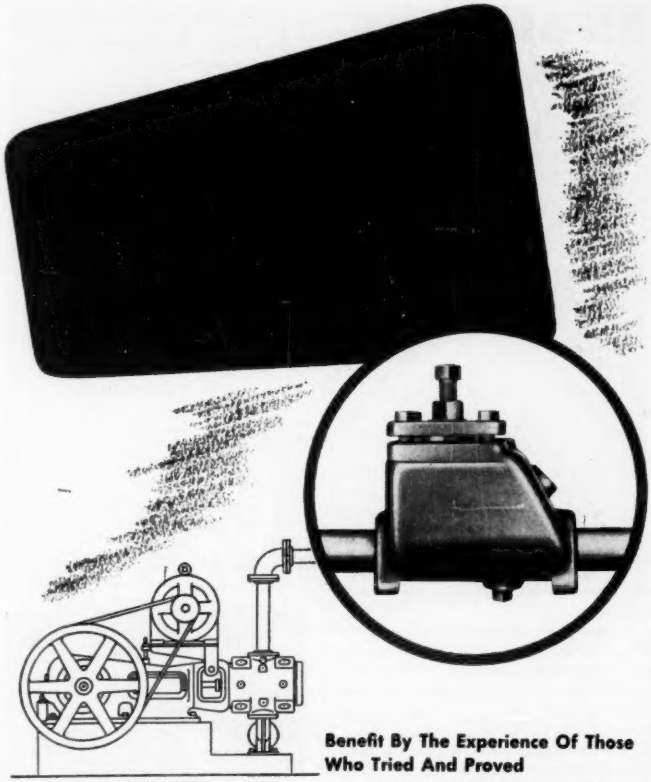
The switch can be operated manually, or electrically by an automatic control device. The operating coils are interchangeable and provide 110, 220, and 440-volt control. Single-pole switches can be ganged mechanically or electrically for three-pole switching duty.

Industrial Betatron

Continental Foundry and Machine Co. recently placed in continuous operation an Allis-Chalmers motorized industrial betatron for production-line inspection of heavy ordnance equipment at its East Chicago, Ind., plant.

Located in the same area originally occupied by a one-million-volt x-ray machine which was too slow for production inspection of large pieces, the new 20-million-volt betatron has greater flexibility and five times the penetrating power of the old machine.

Continued on Page 56



Benefit By The Experience Of Those Who Tried And Proved

The PPC AIRCHECK VALVE

Installed on the discharge line of your air or gas compressor, the AIRCHECK can benefit you too because of its excellent features . . . Adaptable and easy-to-install anywhere, incorporating the exclusive PENNSYLVANIA Air Cushion Valve in a Safe, Dependable Design, it will prove itself to you . . . Equally effective when used as a pulsation-fractionator on many air and gas lines . . . . . A product of the makers of Oilfreair and Oilfregas Compressors and Thrustfre Centrifugal Pumps . . .

FEATURES

- **Dampens Pipe Line Pulsations.**
- **Dispenses with Globe, Safety and Stop Valves.**
- **Permits repairs to any unit, on multi-compressor lines, without shutting down the system.**
- **Prevents leakage of pressure through the compressor when off or idling.**
- **Reduces danger of damage due to human forgetfulness.**

Send for your copy of the new Bulletin No 509-A. Gives full story on how AIRCHECK will help you.

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ENGINEERS

If You're Interested in Yourself—We're Interested in YOU!

You may think this an unusual attitude for an employer to take, but the fact is, "self-interest" is often overlooked and even considered undesirable by some employers.

But here at Honeywell, we believe self-interest is healthy for our employees and for this company. And we back up our belief not only with money, security and the usual "fringe benefits," but also by giving people satisfying, challenging work and opportunity for advancement NOW – not tomorrow or next year.

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So – here at Honeywell – we take great care to put a self-interested engineer in his proper field – research, development or design. We let him loose in basic research. Or we give him meaty problems in electronics and electro-mechanical devices. We let him tear into gyro, servo-mechanism, relay, heat transfer, electrical contact phenomena or aero-elasticity. In other words – we give him the work he wants and needs to do.

Yes, Honeywell goes for self-interested engineers. We want them when we find them and we keep them when we get them.

If this kind of thinking appeals to you, the chances are you'll be mighty valuable to yourself and to us by working at Honeywell. Why not start *right now* to do something about it? Depending on the location you prefer, write to H. D. Elverum, Personnel Department ME-2, Minneapolis 8, Minn. or W. Reiterman, Personnel Dept. ME-2, Philadelphia 44, Pa., giving your qualifications and experience. Your letter will be held in the strictest confidence, of course.

MINNEAPOLIS
Honeywell
First in Controls

• Keep Informed

The betatron is capable of detecting flaws as small as 0.02 in. in castings, forgings, and weldments from one inch to 24 in. thick. It is so flexible that it can examine areas from six inches long to sections over 20 ft in length with no sacrifice in detection ability.

The betatron has a unique mounting which leaves the floor entirely clear for moving and checking large pieces without interference, and thus permits accurate positioning for still radiography. Complete motorization also allows for a smooth sweep to cover a wide band with a continuous motion. Mounted on a 30-ft-high bridge crane, the betatron provides a wide range of speed for each of the five motions.

Continental Foundry is installing a second betatron at its Coraopolis, Pa., plant.

High-Speed Camera

A modification of the Kodak high-speed camera which permits both the mechanical and electrical aspects of a subject to be recorded simultaneously on the same film has been announced by the Eastman Kodak Co., Rochester, N. Y.

The modification consists of the addition of a second lens to the camera to record the images on the tube of a cathode-ray oscillograph through the back of the film, while the mechanical aspects of the subject are being photographed on the front. This

record will permit the photographer to present a complete picture of the behavior of electromechanical devices, and will also permit easy correlation with strain, acceleration, vibration, and other signals fed to the oscillograph in many nonelectrical problems.

Inasmuch as the film is traveling in a vertical direction the horizontal deflecting circuit alone is used. The film speed, as indicated by the edge-marking argon lamp in the Kodak high-speed camera, provides a time base if necessary.

Exposure of the oscillograph trace is continuous, not intermittent like the exposure of the picture image. On any given picture frame, the midpoint from top to bottom of the trace coincides with the midpoint of the exposure time of the picture image. The entire trace from top to bottom of the frame represents a time interval equal to the reciprocal of the picture frequency. This is five times the picture exposure time.

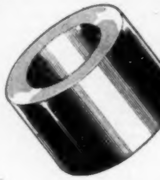
Silicone Rubber Glass Cloth

Silicone-rubber-treated glass cloth for motor and cable insulation is now in production at General Electric's Coshocton, Ohio, plant.

In the dipping process that is used, glass cloth is passed through a liquid solution of silicone rubber. After the application of heat to cure the rubber, the treated fabric is ready for use. The process is continuous.

The chief use of silicone-rubber-treated glass cloth at present is for motor and cable

WORKS WHERE OTHERS WON'T



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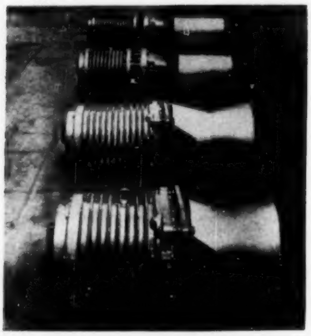
insulation. Having high heat resistance and excellent flexibility and electrical properties, the material is ideal for these applications. It is anticipated that other uses will be developed in the electric industry and requirements for defense applications may require substantial quantities.

Thirty-six inch widths from four to ten mils in thickness are being produced at the Coshocton plant.

Individually Driven Rollers

A recent development of the Loewy Rolling Mill Division of Hydropress, Inc., New York, N. Y., is an individually driven, motor roller unit. The new unit is specially designed for heavy-duty service in rolling mills, pipe mills in back of hydraulic press installations, and other plants where conveyer tables are required.

Because the speed of the Loewy Rollers adjusts automatically to the weight of the load transported, the danger of overloading is eliminated. The rotor has the low inertia necessary for constant start-stop operation. Stator winding wires are glass-insulated and impregnated with silicon varnish capable of withstanding temperatures



up to 350 F. If stopped by accident, cooling ribs allow the motor to be safely stalled under full load for approximately one half hour. A large cavity under the bearings permits packing with high temperature silicon grease.

Each roller is directly driven by an individual motor without couplings, reduction, or bevel gears. The roller motor and supporting bracket form a self-contained unit which can be readily mounted in any desired table pattern. Straight, zig-zag, curved, spiral, and s-shape lines can be installed with single groups controlled individually. Skids can easily be placed between the units and free passage can be arranged between rollers where required.

Plastic Blowers

Plastics are now being used to replace critical aluminum and bronze for blowers in small, totally enclosed, fan-cooled, a-c motors, according to Westinghouse Electric Corp., Pittsburgh, Pa. The plastic blowers consist of a polyester resin reinforced with glass fibers. Glass fiber reinforcement has been found to be superior to organic fiber reinforcement because of increased resistance to chemical attack, and increased strength per pound.

The plastic blower has many advantages over the aluminum and bronze blowers it replaces. It is unaffected by the chemical agents that attack the metals. Hence, it is

Continued on Page 58

NEW HIGHS IN RESOLUTION

THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY
OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long at speeds up to 6000 inches per second
WRITING SPEED as high as 5,000,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
- AUTOMATIC INTENSITY CONTROL.
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.

Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

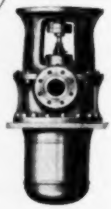
FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2G1-K

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

FOR LESS SERVICING...
AND MORE SERVICE...
AROUND THE CLOCK...
YEAR-AFTER-YEAR...

SPECIFY

Pacific

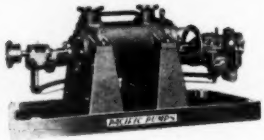


PACIFIC TYPE WBF

Precision Built PUMPS

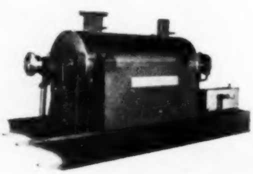
CENTRIFUGAL BOILER FEED

You Specify — The capacity, temperature and pressure.



PACIFIC TYPE ABF

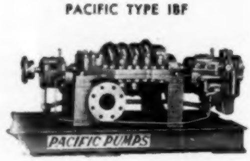
Pacific Will Specify — The most efficient size and the correct materials.



PACIFIC TYPE IBF

You Will Receive from Pacific — A custom built pump with pressure castings, hydrostatic tested... each part precision finished and inspected . . . one-piece impellers, dynamically balanced... performance tested and shipped with parts protected with rust inhibitor.

Write for Bulletin No. 109.



PACIFIC TYPE JBF

Pacific Pumps inc.

HUNTINGTON PARK, CALIFORNIA

BF-13

Export Office: Chanin Bldg., 122 E. 42nd St., New York • Offices in All Principal Cities

• Keep Informed

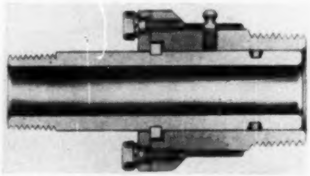
desirable on motors used in refineries, chemical plants, and process industries where corrosive atmospheres may be present.

The plastic blower is as much as one third lighter in weight than its metal counterparts. While this may be but a matter of a few ounces, the reduction of inertia where frequent, rapid reversals are required is worthwhile. Preliminary tests indicate that the plastic blower has better resistance to abrasion than its predecessors.

These advantages are obtained without sacrifice in blower performance. The blower has successfully passed overspeed tests at four times normal speed. Westinghouse currently is applying these new plastic blowers to totally enclosed fan-cooled Life-Line motors in NEMA frames 254 and 284 (5 and $7^1/_2$ hp, 1750 rpm). They will be applied to other motors later.

Swing Joints

Development of a new line of swing joints applicable to gasoline and oil tank car or truck loading and unloading lines is announced by Barco Mfg. Co., Chicago, Ill., maker of flexible pipe joints.



Advantage of the new design is its simplicity in providing for 360-deg rotation around the axis of the joint with a long bearing surface to support the weight of normal piping. When used in pairs, connected by a 90-deg ell, they provide for up-and-down and side-to-side action such as may be desired for loading or unloading lines. Easy arrangement for counterbalancing of supported piping is also provided.

Sizes available range from $^3/_4$ to 3 in. for threaded connections and from 4 to 12 in. with flanged connections. A total of 60 different models are available to meet users' individual requirements. Sealing is by means of an "O" ring confined in a recess in the sleeve of the joint.

Detailed information on Barco Swing Joints is contained in a new bulletin.

• BUSINESS CHANGES

Marley Opens Washington Office

The Marley Co., Inc., manufacturers of Marley water-cooling towers and air-cooled heat exchangers, opened its Washington, D. C., engineering service office on Nov. 1, 1951. The office is located in the Wyatt Building at 777 Fourteenth Street, N. W.

Stone to Handle Entire Wing Line

The Stone Co. of Rochester, N. Y., which has for many years past handled the power plant equipment line of L. J. Wing Mfg. Co., of Linden, N. J. and, in a few counties of western New York, the Wing unit heater line, has been appointed to handle the complete line of Wing products in western New York state, including the entire Rochester area.

• Keep Informed

Whitney Chain Opens New Headquarters

The Whitney Chain Co. of Hartford, Conn., announces the removal of their district sales office to new and larger quarters at 70 Dorman Ave., San Francisco, Calif. The new headquarters will function as the engineering sales outlet for the complete line of Whitney power transmission and conveying chain, couplings, and sprockets in the San Francisco and Northern California regions.

B&W Plans Subcontracts, New Plant

Expanded use of subcontracted facilities, plus plans for a new plant, have been made in recent weeks by the Babcock & Wilcox Co., New York, N. Y. The facilities, located in the East and South, will add to the company's regular force of 14,000 a possible 1900 employees. The reason for the expansion was to have available necessary additional fabricating operations to speed production of badly needed boiler parts when anticipated increases in steel and other materials for this work become available during the fourth quarter of the year.

Flexitallic Adds Six New Agents

Flexitallic Gasket Co., Camden, N. J., recently announced the addition of the following six new agents and one new distributor to its field organization: Jno. D. Hiles Co., Inc., Pittsburgh, for western Pennsylvania and eastern Ohio and portions of West Virginia; Engineering Products Co., Charleston, W. Va., for West Virginia, eastern Kentucky, and part of Ohio; Chapman Engineering Sales Co., Cincinnati, for southwestern Ohio and northern Kentucky; De Haven Engineering Co., Indianapolis, for Indiana and western Kentucky; Steel & Engineering Products Co., El Paso, Tex., for southwestern Texas, southern New Mexico and Arizona; Energy Control Corp., Philadelphia, for eastern Pennsylvania, southern New Jersey and Delaware. Fleck Bros., Ltd., Vancouver, B. C., is a new Flexitallic distributor and will serve the western provinces of Canada.

Hamilton Completes Metal-Treating Plant

As part of its expansion and modernization program, Hamilton Mfg. Co., Two Rivers, Wis., announces that its new metal-treatment and metal-finishing plant is now in full operation.

This new system involves the most modern equipment available today. These extensive finishing facilities are housed in a completely new steel structure, 221 ft long × 53 ft wide, which has been added to the upper floor of the steel fabricating plant. More than a mile of automatic conveyers, in three separate lines, are used in moving fabricated steel parts from the press and welding operations through the new finishing plant and from there to several assembling and trimming departments.

Three basic steps are involved in the new metal-finishing operation. These are: (1) Metal preparation, (2) metal finishing, and (3) high-temperature baking of the final finish. Three entirely separate conveyer lines, originating from different areas of the steel-fabricating plant, pass through all stages of the finishing operations. This lends considerable flexibility, in that fabricated metal parts can be hung on any one line or on all three of the conveyer lines so that every metal product can be subjected to the multiphase finishing process.

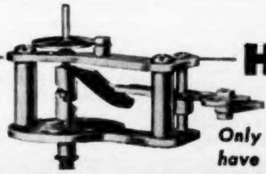
Continued on Page 60

PLUS Helicoid Gages

This Vacuum Gage is an example of the extra value at no extra cost in all HELICOID GAGES.

Note:

1. Dial in inches of mercury vacuum, reading counterclockwise, to denote negative pressure and prevent confusion with a 30 lb. pressure gage.
2. Even if subjected to 30 lb. pressure, no harm will result because the Helicoid cam releases from the roller on the pressure side. Other vacuum gages are damaged by pressure.
3. Subdivisions in graduated steps of 0.2 inches for ease in reading scale.
4. Hairline Pointer adjuster to correct zero setting for changes in barometric pressure.
5. Guaranteed accuracy to within 0.15″.
6. The new square flush case. Another Helicoid "*first*."



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

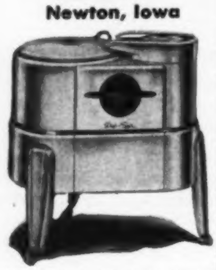
HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

THIS LUBRICANT

SAVES GEARS AND TRANSMISSIONS

—says
AUTOMATIC WASHER COMPANY
Newton, Iowa



They write us.

"We have used LUBRIPLATE in our washing machine transmissions since 1933. Our laboratory tests as well as field experience indicate that through the use of LUBRIPLATE we reduced the wear on the gears and prolonged the life of the transmission.

"The transmission is the heart of any washing machine, and the long life and trouble-free performance obtained by the use of LUBRIPLATE in the Automatic Washer transmission has been an important factor in the success of our product."

AUTOMATIC WASHER COMPANY
F. Breckenridge
Executive Vice-President

The use of LUBRIPLATE in a washing machine is a severe test. Bearings and parts are subjected to moisture, hot water, caustics and sometimes acids. A lubricant to give efficient lubrication under these conditions must be an unusual product.

LUBRIPLATE Lubricants reduce friction and wear, prevent rust and corrosion, save power. Because LUBRIPLATE Lubricants last longer, they are more economical to use.

Let us send you CASE HISTORIES of the use of LUBRIPLATE Lubricants in your industry. There is a LUBRIPLATE product best for every lubrication need. They range from the lightest fluids to the heaviest greases. They are different from any other lubricants you have ever used. Write today for further information.

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Fiske Brothers Refining Company
Newark 5, N. J. Toledo 5, Ohio

DEALERS EVERYWHERE . . . CONSULT YOUR CLASSIFIED TELEPHONE BOOK

LUBRIPLATE THE MODERN LUBRICANT

• Keep Informed

Lincoln Electric Moves Into New Plant

Office workers of the Lincoln Electric Co. recently moved all executive and plant offices with their equipment into the company's new headquarters at 22801 St. Clair Ave., Cleveland 17, Ohio.

The office move was but one step in the transferring of Lincoln's operations without losing any more than 10 per cent of production for the month during which the complete move was made.

Westinghouse Air Brake Co. Acquires Melpar, Inc.

Westinghouse Air Brake Co. has purchased all of the stock of Melpar, Inc., of Alexandria, Va., and Cambridge, Mass., according to recent announcement.

Melpar, Inc. is actively engaged in the research and development programs of the Armed Services. This includes prime contracts with the Air Force, Navy, and Signal Corps, covering the fields of radar, sonar, communications, guided missiles, computers, and miniaturization. In addition to these diverse electronics activities, the Melpar organization also maintains a very complete chemical laboratory.

Western Gear Works Starts New Construction

Beginning of new construction that will increase gear-manufacturing capacity by 30% at the Lynwood, Calif., plant of Western Gear Works was recently disclosed. This is reported to be the first in a series of expansion moves planned for this Southern California plant of the company.

Construction of a new plant by the same company is currently underway at Belmont, Calif. A third plant is located in Seattle. Associated companies operate plants in San Francisco and Houston.

Link-Belt Opens New Factory Branch Store

Link-Belt Co. announces that it has opened a new factory branch store at 108 South Fourth West Street, Salt Lake City, Utah, in order to better serve the mines, mills, and factories in Utah, southern Idaho, and eastern Nevada with their power transmission and materials-handling machinery requirements.

Westinghouse to Undertake $296,000,000 Expansion

The Westinghouse Electric Corp. will undertake a $296,000,000 expansion program extending beyond 1953, President Gwilym A. Price announced recently.

The expansion program will be the second such program undertaken since the end of World War II. The first, announced in 1945, was completed in 1948 at a cost of approximately $150,000,000 and increased manufacturing facilities by 50 per cent.

Major projects already undertaken are as follows:

A new plant in Raritan Township, N. J., which will soon begin manufacture of electronics equipment; a small motor plant at Union City, Ind., now more than half completed; electronic tube plants at Elmira and Bath, N. Y.; an aircraft-armament plant at Baltimore, Md.; a jet engine parts plant at Columbus, Ohio; an expanded plant for generator output at East Pittsburgh, Pa.; five new lamp plants; the purchase of a plastics plant at Hampton, S. C.; and provision for substantial increases in production of household appliances and television sets.

• Keep Informed . . .

Chain Belt Announces New Sales Offices

Chain Belt Co. announces appointment of the Cate Equipment Co. as its new district sales office in the Salt Lake City, Utah, area.

For the past 18 months Cate has served as a distributor for Rex and Baldwin-Rex chains and sprockets, Rex belt conveyer idlers and power transmission equipment. As a District Sales Office, it will continue to maintain its distributor status and carry stocks of these items for prompt local service.

Chain Belt Co. also announced that the new location of its Milwaukee district sales offices, would now be located at 4532 West Greenfield Ave.

World's Largest Jet Plant

Jet engines for Navy and Air Force fighter planes are coming off the final assembly line at the Westinghouse Electric Corp. turbojet plant at Kansas City, Mo., only hours apart. The 85-acre plant, whose main production aisles are almost a quarter of a mile long, is said to be the largest and most complete jet-engine-production facility in the world.

Westinghouse jets are built almost entirely of stainless steel, aluminum, and magnesium, in order to produce the combinations of strength, heat-resistance, and lightweight so vital to high-performance aircraft engines.

Production in the huge plant is organized on the flow system, with raw materials entering by truck or freight car (the plant's roofed railroad siding accommodates 20 loaded freight cars at a time) at one end, and flowing out the other as completed engines, ready either for immediate installation in fighting planes or for shipment and storage as "spares" at forward military areas or aboard carriers of the fleet.

Multiple-processing lines—for shearing, bending, stamping, welding, machining, fitting, and subassembling—flank the quarter-mile-long row of production offices, tool cribs, and tool and patternmakers' shops down the center of the main manufacturing center. A complete forge shop for the fashioning of compressor blades, and mass production facilities for the lost-wax precision casting of turbine blades, feed their output to the final assembly section.

Continued on Page 62

GIVE *Voluntarily* TO
MARCH OF DIMES
JANUARY 2-31

JANUARY

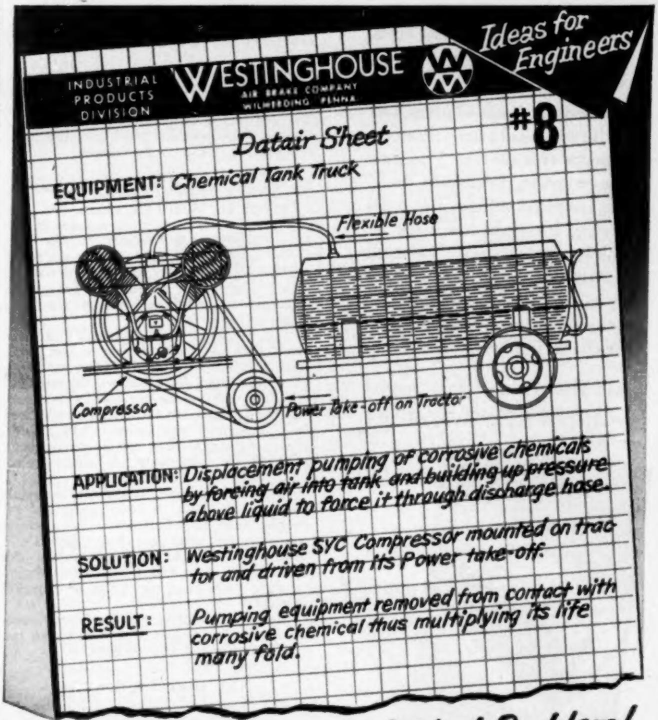
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

NMB Enlarges Facilities

Expansion in the manufacturing facilities of National Motor Bearing Co., Inc., and its subsidiaries has been announced. The home plant and offices at Redwood City have been enlarged; additional building is under way at National Seal Co., NMB's eastern subsidiary at Van Wert, Ohio; and Arrowhead Rubber Co., another subsidiary at Downey, Calif., recently moved its air duct manufacturing division into a new factory at Long Beach. It was also announced that the company is revamping its executive setup in order to make fullest use of the increased physical facilities.

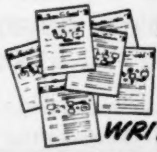
Hyatt to Expand Facilities

The Hyatt Bearings Division of General Motors Corp. announces that preliminary plans are now complete for expansion of the manufacturing areas in the Hyatt plants in both Harrison and Clark Township, N. J. Increasing demand for roller bearings in the National Defense Program has necessitated this expansion of manufacturing facilities. New structures at the Clark Township plant will provide an additional 390,000 sq ft of floor space doubling the existing facilities. Alterations to the Harrison plant will provide an additional 12,000 sq ft of manufacturing area.



So often AIR Solves the Control Problem!

In case after case, Plant Engineers are using W A B Pneumatic devices to solve control problems. The case presented above is an example. Our Engineering Data File provides information concerning this and many others. Sections of it may be applied to your problems. Write for a complete file. No charge.



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It is inevitable, and fortunately, it is easy, so why not change now? This has been going on, on a merit basis, for years.

Our booklet (below) gives you all the practical facts you need to make the switch. You can save money; you will help the national effort by conserving tungsten for uses in which it is really needed. Above all, you will get a tool which is every bit as good as a tungsten type—many people think better!

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Position ....
Company ....
Address ....

MOLY

ME12 HS-9

• Keep Informed

Edward Pittsburgh Office at New Address

Edward Valves, Inc., East Chicago, Ind., has moved their Pittsburgh, Pa., sales office to the Investment Building, Room 2101, 235 Fourth Ave.

The Pittsburgh sales district covers West Virginia, Southeastern Ohio, and the west and northeast areas of Pennsylvania.

Westinghouse Awarded Contract for Atomic Power Facilities

The Westinghouse Electric Corp. has received a $6,700,000 contract for equipment to carry electric power to the Paducah, Ky., Atomic Energy Plant. The multimillion dollar contract was received from the F. H. McGraw Company, which is building the new plant for the Atomic Energy Commission.

Included in the contract are large numbers of 10 million-kva circuit breakers—largest ever constructed for use on 161-kv lines. The contract also provides for many low-voltage circuit breakers and unit substations, and five 100,000-kva transformers.

Du Mont Gears Facilities for Defense

Allen B. Du Mont Laboratories, Inc., has disclosed several transitional changes in the huge 480,000-sq ft facility, which will enable Du Mont to make a fuller use of its productive capabilities for the national defense effort. The transition was made recently and additional changes are being planned.

With Du Mont's anticipated TV receiver production set at 40 per cent of last year's total because of the needs of raw materials for our country's defense effort, the company disclosed that two of the plant's four conveyerized production lines had been allocated to government production. Additionally, areas on the remaining two lines have been reserved for conversion to military electronic components manufacture.

In a move designed to facilitate materials handling Du Mont is rearranging and rerouting more than half a mile of overhead conveyers and more than three quarters of a mile of gravity roller conveyer systems. All told, the Du Mont East Paterson installation contains more than two miles of conveyer systems.

Materials handling will be further facilitated by the institution of a new and improved in-line testing procedure.

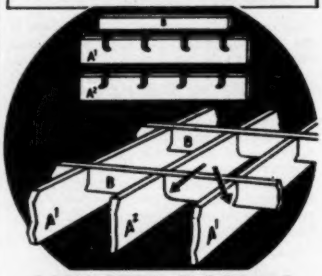
NYU Gets G-E Contract

The General Electric Co. has awarded a contract to the Research Division, New York University College of Engineering, to cover special studies related to the flow of gas through jet-engine compressors, as part of G-E's research program for aircraft power plants of advanced design. The work will be done for the G-E's Aircraft Gas Turbine Department. Dr. Chi Teh Wang, Professor of Aeronautical Engineering at NYU, will direct the research project.

Chain Belt Constructing Warehouse

A new 100 × 111-ft warehouse providing expanded facilities for servicing the Pacific Northwest is now being constructed for Chain Belt Co. in Portland, Oreg. Besides housing increased stocks of chain, sprockets, power transmission equipment, take-ups, elevator buckets, belt conveyer idlers, and spray nozzles, the new building will also contain the company's Portland District sales office.

NO BOLTS, RIVETS, OR WELDS WITH TRI-LOK



OPEN STEEL FLOORING

Tri-Lok open steel flooring is fabricated of cross-bars (see B above) twisted in opposite directions at each bearing bar (note arrows on A¹, A²), and pressed into position by a 1600-ton press! Truss action forms a rigid framework ideal for stairs, walkways, decks, loading platforms, and engine room installations.

Maximum openings allow ample light and ventilation, but no object over one-half inch square can slip through. Rectangular or U-type construction. Variety of metals—stainless steel, aluminum alloy, etc. Riveted and Tri-Forge welded flooring available. Write for Bulletin PJ-1103.

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Our volunteer speakers are saving thousands of lives *today*... in factories and offices, at neighborhood centers and at organization meetings all over this land... showing people what they can do to protect themselves and their families against death from cancer.

For information just telephone the American Cancer Society or address a letter to "Cancer," care of your local Post Office.

American Cancer Society

• Keep Informed

Chiksan Names Export Sales Representative

Hydrobel, S. A., Liege, Belgium, has been appointed export sales representative by Chiksan Co. for Belgium, Grand Duchy of Luxembourg and the Belgian Congo. This company, which represents a number of American manufacturers, will specialize on the sale and application of Chiksan industrial and hydraulic swivel joints and WECO unions.

B&W Tube Co. Moves Sales Office

The local district sales headquarters of The Babcock & Wilcox Tube Co., Beaver Falls, Pa., formerly established at the plant, has moved to 712 Eleventh St., in Beaver Falls. The new office occupies a complete building leased and remodeled by the Tube Co. and is convenient to railroads, other public transportation, and the local hotel. The office handles the sale of B&W seamless and welded stainless, alloy and carbon-steel tubing in western Pennsylvania, western New York, Ohio, southern Indiana, and the states of Kentucky, West Virginia, Tennessee, North Carolina, South Carolina, Georgia, Alabama, and Florida, and parts of Canada.

• LATEST CATALOGS

Explosionproof Motors

An 8-page bulletin recently issued by U.S. Electrical Motors, Inc., Los Angeles, Calif., includes classifications and features of U.S totally enclosed and explosionproof motors.

Chemical Processing Equipment and Blowers

A new 12-page catalog on Read Standard chemical processing Equipment and Standardaire blowers is available from Read Standard Corp., York, Pa.

Tensiometer

An 8-page two-color bulletin, No. GEA-5512, on the G-E tensiometer, a device for continuous tension indication of cold-rolled strip in steel, brass, and aluminum mills, is available from the General Electric Co., Schenectady, N.Y.

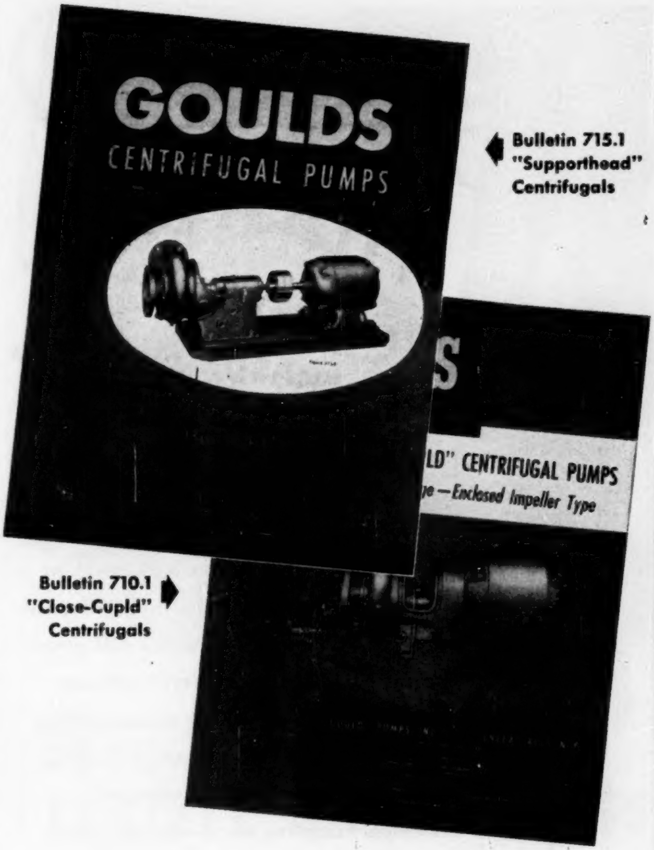
Pressure Switches

A 32-page manual on pressure switches is available from Barksdale Valves, Los Angeles, Calif. The book includes a glossary of terms, a tabulation of available units based on function and pressure or vacuum range, diagrams for circuit detailing, an electrical rating table, and other important application data. It presents a comprehensive coverage of operating characteristics for diaphragm, Bourdon tube, and piston-type pressure-actuated switches, from extreme vacuum to extreme pressure.

Chronoflo Telemeter

Builders-Providence, Inc., one of the B-I-F Industries, Providence, R. I., has issued a new 8-page bulletin, No. 230-H4, on Chronoflo Telemeters which make possible the transmission of information and controls over a simple two-wire electrical circuit for unlimited distances. The bulletin lists the many features of the device, describes the operation of the transmitter and receiver, and shows photographs and diagrams to illustrate the mechanism and installations.

Continued on Page 64



Bulletin 715.1 "Supporthead" Centrifugals

Bulletin 710.1 "Close-Cupld" Centrifugals

These new bulletins make it easier for you to select the right pump

These new bulletins have been designed to help you. New sizes are listed, and, in each bulletin we have put a composite rating chart which includes both "Close-Cupld" and the supporthead. This makes it dead simple to put your finger on the right pump for your requirements.

Another valuable feature of these bulletins is the parts chart. Using this you see exactly what parts are interchangeable for all size pumps and so can keep your spare parts investment to a minimum.

Use the coupon below to send for these useful FREE bulletins *today*. Goulds Pumps, Inc., Seneca Falls, N. Y.

Goulds PUMPS INC. Seneca Falls New York

GOULDS PUMPS, INC.
Dept. ME, Seneca Falls, N. Y.
Send Bulletin 710.1 ☐
Bulletin 715.1 ☐
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Company________
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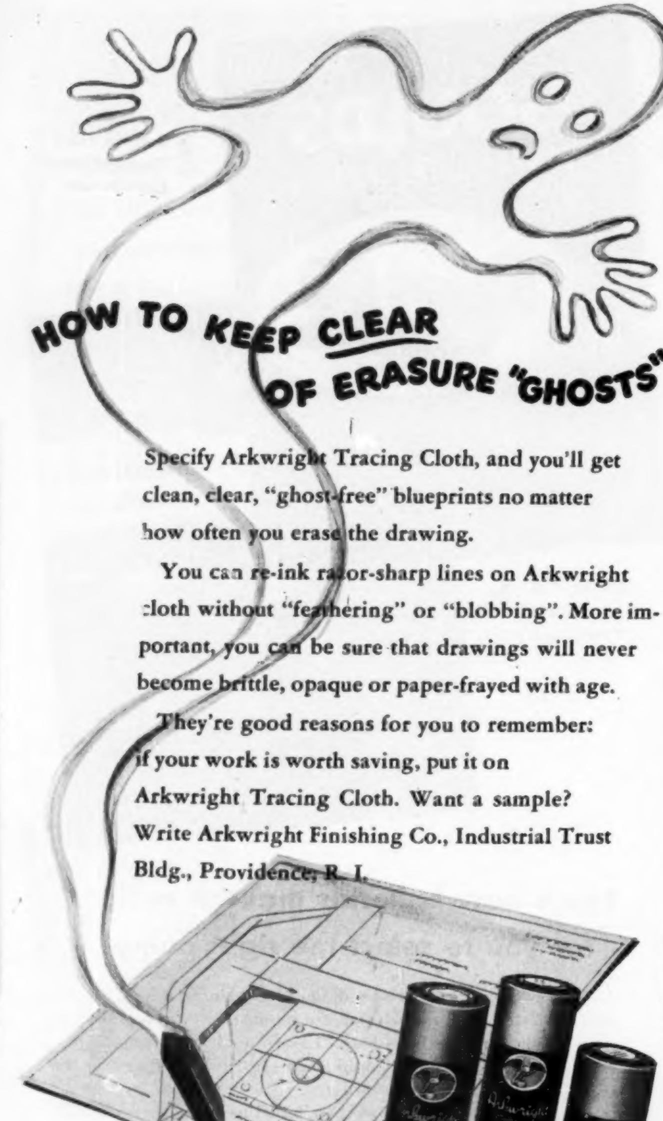
City________ Zone____ State____



• Keep Informed

Totally Enclosed Motors

Advantages and limitations of totally enclosed motors with air-to-water heat exchangers are related in a new bulletin, No. 05B7682, released by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. The bulletin includes a description of the three types of cooler arrangement—foundation, side, or top-mounting—built into the motors and explains how to estimate their water requirements.

Recording Oscillograph

The 5-114 recording oscillograph, a multichannel, precision instrument for the analysis and measurement of strain, vibration, pressure, acceleration, and other phenomena, is the subject of a fully illustrated technical bulletin, No. 1500B, published by Consolidated Engineering Corp., Pasadena, Calif. Highly compact and versatile, this instrument records photographically up to 18 separate, static or high-frequency phenomena simultaneously at record speeds of $^1/_8$ to 115 in. per sec. It also records timing lines at $^1/_{100}$ sec intervals so that each phenomenon can be interpreted not only in relation to others but in relation to time.

Expansion Joints and Aircraft Bellows

A new catalog containing over 78,000 possible combinations of bellows-type expansion joints has been published by the Solar Aircraft Co., San Diego, Calif. It also contains a complete line of aircraft bellows and assemblies. This new 40-page catalog serves as a reference handbook and it illustrates a diversified line of standard and special bellows assemblies used to take up expansion, contraction, and offset movements in pipes and conduits.

Materials-Handling Products

"How the Products of Clark Serve Industry" is the title of a new 32-page booklet which illustrates and briefly describes the products of Clark Equipment Co., Buchanan, Mich. The booklet shows a number of Clark axles and transmissions for trucks and busses, the unique one-piece forged Clark axle housing, combination axle-transmission drive units for farm tractors, road and earth moving machinery, and gears and forgings. Also described and illustrated is the broad line of Clark industrial towing tractors, fork-lift trucks and attachments, powered hand trucks, and stackers that put modern materials-handling techniques into profitable practice wherever they are used.

Arc-Welding Electrodes

A booklet covering nickel-molybdenum-vanadium alloy-steel-shielded arc-welding electrodes (low-hydrogen type) is available from International Nickel Co., Inc., New York, N. Y. It contains 19 pages with 32 illustrations, diagrams, and charts by three welding specialists of the Industrial Test Laboratory, Philadelphia Naval Shipyard. Summarizes results obtained with commercially available rods that produced, without preheat in high-strength steels, crack-free welds which in the as-welded condition consistently exceeded 110,000 psi yield strength with maximum ductility. These electrodes meet Navy Spec. MIL-E-986 Grade 260. Operating characteristics, welding procedure, and the importance of low moisture content in the electrode coating are described. This low-alloy ferritic NI-MO-V type of electrode developed 100 per cent joint efficiency as compared with 70 per cent for the most popular rod previously used.

• Keep Informed

Liquid-Level Gages

A new bulletin, No. 176, released by Jerguson Gage & Valve Co., Somerville, N. J., describes and illustrates the Jerguson Truscale remote-reading liquid-level gages.

Automatic Aircheck Valve

The PPC Aircheck valve is described in bulletin No. 509, issued by Pennsylvania Pump and Compressor Co., Easton, Pa. The PPC Aircheck valve safeguards against the forgetfulness of operating personnel to open a valve when starting up. In addition, the Aircheck valve (1) dispenses with customary arrangement of stop, safety, and globe valves; (2) prevents leakage of pressure through the compressor during the "off" cycle; (3) dampens pipe-line pulsations; (4) permits repairs without shutting down the system where more than one compressor is on the line.

Plastics Booklet

A new 24-page booklet now being distributed by the Richardson Co., Chicago, Ill., gives the layman a basic introduction to the many different plastics now in use, the various ways they are produced, and the uses of plastics in industrial and consumer products.

Subjects covered include: history of plastics; plastics advantages and limitations; thermosetting and thermoplastics materials; how laminated and molded plastics are made; design suggestions; industrial and consumer applications; comparative properties of different grades; and products, facilities, and services of the Richardson Co.

Nisiloy

Nisiloy for gray iron castings, an 8-page folder describing an innoculant, metallurgically designed to improve machinability, add toughness, and increase resistance to wear is available from International Nickel Co., Inc., New York, N. Y. Improved production figures, reduced rejects, longer tool life, and other machine-shop economies are described resulting from structural uniformity from lot to lot and the elimination of chilled white iron or hard spots without annealing.

Kodagraph Autopositive Paper

How short cuts and savings have been effected through use of Kodagraph Autopositive Paper in engineering drawing room reproduction is told in a new booklet issued by the Eastman Kodak Co., Rochester, N. Y. The booklet contains ten case histories of highly successful operations in drafting room, reproduction department, and shop. Kodagraph Autopositive Paper is a low-cost photographic intermediate material which gives positive copies directly, can be handled in room light, and can be printed with existing equipment.

Controlled Volume Pumping

An illustrated, 24-page, 2-color bulletin on controlled volume pumping and Milton Roy controlled volume pumps has recently been published by Milton Roy Co., Philadelphia, Pa. Bulletin No. 151 will be of interest to industrial plants whose operations call for pumping a controlled volume of liquid in amounts as much as 50 gpm or as little as 3 milliliters per hr. The bulletin gives complete details on controlled volume pumping, describes the features of the controlled volume pumps, and includes data required for selecting Milton Roy pumps for specific applications.

Continued on Page 66

Use BARCO
FLEXIBLE BALL JOINTS

THE SOLUTION FOR MANY PROBLEMS! The BARCO Flexible Ball Joint is one of the most useful, most versatile fittings ever developed for application on piping conveying steam, oil, gas, water, air, chemicals, refrigerants, or other fluids. Find out how these simple, rugged, economical joints can help you:

- Overcome piping misalignment! Provide simple, trouble-free flexible couplings for steam or air lines.
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- Protect piping against strain, stress, settling, shock, or vibration! Excellent for outside service piping connections to buildings, large storage tanks.

COMPLETE LINE—15 different sizes, ¼" to 12". Angle or straight, male or female threaded connections—flanged connections—welding ends for welded connections. Available in materials suitable for temperatures from -50° to as high as 1,000° F.; for pressures from vacuum to 750 p.s.i. steam, or 6,000 p.s.i. hydraulic. Fire-proof, pressure-safe! Standard throughout the world—available through leading supply companies.

ENGINEERING RECOMMENDATIONS—Barco factory and field engineers are ready to help you solve your problems. ASK FOR NEW CATALOG NO. 215 "BARCO FLEXIBLE BALL JOINTS."

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The Only Truly Complete Line of Flexible, Swivel, and Revolving Joints
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why carry three spares when one can do the trick?

Years ago a motorist loaded down his car with plenty of spares. He had to. Tire design was such that blowouts were commonplace — and expected.

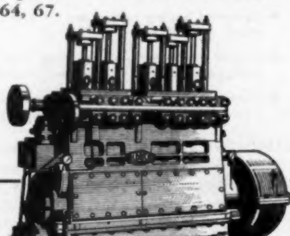
But look at the trim modern car! One spare is plenty—and it's seldom used.

Similarly, not so long ago a company had to stock three or more sets of spare parts to cover reciprocating pump needs. Today, the same company—by using Aldrich 5″ Stroke Direct Flow Pumps—inventories but *one* set of spares to cover a 100 to 275 hp range.

Construction of Aldrich Direct Flow Pumps features wearing parts—valves, plungers, packing, crossheads, wrist pins, etc.—interchangeable within *each* stroke series. This covers 3, 5, 7 and 9 plunger units for the 5″ series ranging up to 275 hp, or for the 6″ series, from 300 to 900 hp. Rather than enlarge the stroke, Aldrich added cylinders to increase pump capacity.

To what advantage?—You benefit through interchangeability, fewer spare parts to tie up money and space, simplified maintenance, and better protection against shut-down . . . all made possible through greater standardization and improved design.

Applications where you'll find Aldrich Direct Flow Pumps saving maintenance time and dollars include: hydraulic systems for press operation; plastic and rubber molding and extrusion; steel mill descaling, and other uses in the petroleum and chemical industries. . . . Write for Data Sheets 64, 67.



THE ALDRICH PUMP COMPANY

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Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.

• Keep Informed

Valve Guide

A handy, quick-reference guide to Edward cast and forged-steel valves primarily for power-plant installations, including industrial, is now available from Edward Valves, Inc., East Chicago, Ind. Designed for easy valve reference and identification, the new bulletin illustrates and describes only those Edward steel valves applicable to power-plant use. Other Edward valves are listed, but with brief descriptions only.

Protective Lighting

Complete plans for outdoor industrial lighting are provided in a new 24-page booklet, No. B-4791, "Light for Plant Safety and Security," available from the Westinghouse Electric Corp., Pittsburgh, Pa. Stressing that protective lighting is good productive lighting, the booklet sets forth four principles: (1) Discourage attempts at entry; (2) make detection certain if entry is attempted; (3) aid the guard and hinder the intruder; (4) provide complete reliability.

Welding Rods

A new edition of the booklet, "Anaconda Welding Rods and Procedures," is announced by Anaconda Copper Mining Co., New York, N. Y. Applications and procedures are suggested for production and repair welding, and for building up worn surfaces with bronze rods. Welding techniques discussed include the oxyacetylene torch, metal-arc, carbon-arc, and inert-gas-shielded arc. U. S. Navy and Federal Specifications, as well as other tabular data on copper and copper-alloy welding rods are also included.

Power-Conversion Units

A new two-color booklet, No. GEA-5658, on the G-E metallic rectifier power-conversion units is available from the General Electric Co., Schenectady, N. Y. The bulletin describes the features of the equipment, its application, and operation. It is illustrated with photographs, line drawings, and charts showing efficiency and regulation curves for the various sized units. A specification guide for General Electric d-c power supplies and exciters is also included, as well as complete rating charts and dimensions.

Clutches and Drives

A 32-page "Cross Country" issue of *Production Road* describing almost 60 applications of friction clutches and hydraulic drives in as many types of machinery and equipment, has been released by Twin Disc Clutch Co., Racine, Wis. Applications of Twin Disc drives, as original equipment or in repowering machinery, are depicted in various industries—agriculture, aggregates, construction, manufacturing, processing, mining, petroleum, logging, and transportation, highway, off-highway, rail, and water—presented with photo and performance reports.

Vertical Induction Motors

Data on ratings, construction, and types of large vertical induction motors are contained in a new bulletin No. 05B7629, released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Widely used for pumps and other vertical drives, vertical solid shaft induction motors described in this bulletin are available in ratings upwards from 60 hp at 200 rpm. Except for bearing arrangement, mechanical construction of the motors is basically the same as that of horizontal units.

• Keep Informed . . .

Marking Metal Parts

An illustrated color folder showing the most popular methods of marking name plates, metal parts, and products with interchangeable numbering, lettering, or design is now available from Acromark Co., Elizabeth, N. J., with complete price list. Illustrated are such tools and machines as stamps, dies, Hercules holders, numbering machines, name-plate stamping machines, hand and power-marking machines.

Solenoid Oil Valves

Catalog No. 710 just printed, by Hauck Mfg. Co., Brooklyn, N. Y., describes the Hauck solenoid valves for dependable shut-off on oil pressures up to 300 psi heavy grades as well as light fuel oils, oil temperatures up to 250 F, and both UL and FM approval. A rotating cam feature, explained in the booklet, provides a shearing and wiping action to clear away any foreign particles in the oil and insure shut-off of oil without leakage.

Induction Frequency Converters

A new four-page, two-color bulletin, No. GEA-5637, on Tri-Clad induction frequency converters is available from the General Electric Co., Schenectady, N. Y. The booklet covers three-phase equipment in ratings from $^3/_4$ to 100 kw. It describes the fundamentals, operation, and construction features of the high-frequency power supply apparatus, and includes application information, modifications and limitations, and complete tables of ratings and frame sizes.

Centrifugal Blowers and Compressors

A new bulletin No. 0500, issued by De Laval Steam Turbine Co., Trenton, N. J., contains comprehensive data on three types of De Laval centrifugal blowers and compressors: multistage, single stage, end suction, and single stage double suction. Capacities range from 1000 to 150,000 cfm for pressures to 150 psi and above. Special units for higher pressures and for service at operating pressures to 1000 psig.

Pumps

Construction features of oil-lubricated bearing, pedestal-mounted pump for handling chemicals, liquors, corrosive materials and solutions, hot liquids, and petroleum are described in a new six-page bulletin, No. 52B7638, released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Six alternate sealing arrangements are shown and dimensions and specifications of the pump, available in capacities to 1200 gpm at heads to 250 ft and temperatures to 500 F, are given.

Stokers

A new 24-page booklet, telling how to burn refuse or coal (separately or in combination) with Detroit stokers is available from Detroit Stoker Co., Detroit, Mich. Although early installations were comparatively small units equipped with the Detroit RotoStoker, introduced in 1931, installation of the Detroit RotoGrate stoker for medium-size and large units burning refuse fuels have now been made. Typical installations of both types of these Detroit stokers are included in the booklet.

Boiler Valves

A new bulletin on valves for boiler services, such as surface blow, bottom blow-off, water-column blow-off, and connections, has been published by Everlasting Valve Co., Jersey City, N. J. The bulletin describes the Everlasting quick-opening and slow-opening straightway valves, angle valves, "Y" valves, and duplex blow-off units, with complete specifications, materials of construction, and dimensions of each type.

Nickel Alloy Cast Irons

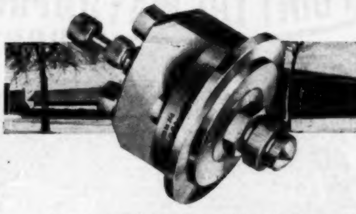
A 36-page bulletin describing eight types of austenitic nickel alloy cast irons that offer unique combinations of properties is offered by International Nickel Co., New York, N. Y. Applications and comparative service data in many industrial fields are presented to prove its utility in withstanding corrosion, heat, wear, and low temperature. High or low controlled expansion, magnetic or non-magnetic properties, and resistance to thermal shock add variety to its usefulness.

Photoelectric Counter

Photoswitch photoelectric counter set P2C is one of several new photoelectric counter combinations offered by Photoswitch Inc., Cambridge, Mass. These are described in bulletin PA 506 which features, in addition, other counter sets to meet the requirements of practically every type of counting installation. Counting combinations are included, providing for both plug-in and permanent wiring, and for location of phototubes both integral with the photoelectric control and in small remote housings.

Continued on Page 68

to the 99 plants in 100 who use SPRAY NOZZLES



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In the search for doing things better and faster, have you overlooked the importance of spray nozzles? Your application may be commonplace or complex . . . but whatever it is, properly engineered spray nozzles can make a vast difference. Let Spraying Systems Co., America's foremost authority on industrial spray nozzles show you why and how. As a first step, write for catalogs.

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Scottie Junior Boilers

Catalog No. 99, issued by Kewanee Boiler Corp., Kewanee, Ill., illustrates and describes the Kewanee Scottie Junior Boiler for 125 lb working pressure and designed for oil or gas firing. It contains a complete description of its many quality features and detailed listings of ratings, dimensions, standard equipment, and trim.

Boiler Blow-off Valves

A new Yarway bulletin No. B-425 (1951) issued by Yarnall-Waring Co., Philadelphia, Pa., replaces the corresponding bulletin printed two years ago. The new issue gives up-to-date information of Yarway blow-off valves for pressures up to 400 lb and supplements the Yarway bulletin B-433 on high-pressure blow-off valves.

Cast Steels

A new booklet issued by Lunkenheimer Co., Cincinnati, Ohio, describes Lunkenheimer cast steels, their manufacture, their properties, and their applications in a simple and nontechnical manner. There have been many advances in the steel valve field. Central-station operating temperatures have increased. High pressures are used. New designs have been introduced. New alloys have been proposed. Welded joints are more universally employed. These and other changes have brought new problems of safety and of economical maintenance. As a result, now more than ever before, it is necessary for the valve user to be cognizant of the inherent qualities of steels now being used in steel valve construction.

Punch Press Motors

A new technical bulletin, No. F-2, on Type F punch press motors has been published by the Howell Electric Motors Co., Howell, Mich., and contains a wide range of technical data and application information on high-slip, high-torque motors for punching, forming, and shearing machines.

Synchronous Motors

Standard construction features of its low speed, coupled-type, pedestal-bearing synchronous motors are described in a new bulletin, No. 05B7648, released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The features described are available in Allis-Chalmers pedestal-bearing synchronous motors in ratings approximately 100 hp and larger at speeds of 450 rpm or less. Motors of 1.0 power factor or 0.8 or better leading power factor are available.

Basic Materials Handling

Efficient handling of raw and finished materials, their proper storage, and how modern materials-handling machines can expedite manufacture to cut costs, save time, and money, is the theme of a new booklet, "Basic Facts About Materials Handling," issued by Clark Equipment Co., Battle Creek, Mich. How to combine small units into big ones for more efficient handling, how to route materials, how to utilize "over-head" space for storage, how to use trailer trains, and how to best make use of a limited manpower force are a few of the subjects discussed in the booklet.

Radial and Universal Driveshafts

A new bulletin, No. F 41-51, on Morse Morflex radial and universal driveshafts is available from Morse Chain Co., Detroit, Mich. The bulletin gives complete data and specifications on Morflex radial driveshafts with spline-jointed tubular shafts; Morflex universal driveshafts with one-piece tubular shafts; and Morflex universal driveshafts with spline-jointed tubular shafts. It also provides a working table of maximum recommended lengths and speeds.

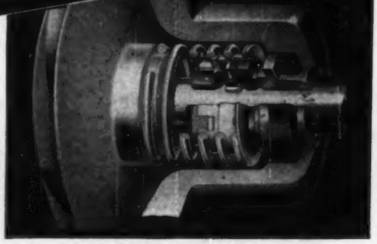
Pump Engineering Data

A new 446-page data book containing general information on centrifugal pumps, principles of pump engineering, general engineering data, and selection tables on centrifugal, axial, and mixed-flow pumps is for sale by Economy Pumps, Inc., Division of Hamilton-Thomas Corp., Sedgley Ave. at 19th and Lehigh, Philadelphia 32, Pa. Price $3.

Lubricated Valves

The Rockwell Mfg. Co., Pittsburgh, Pa., announces availability of Catalog V-215, "Nordstrom Lubricated Valves," which describes types, operation, and principles of operation of Nordstrom plug valves, with reference to over 26 typical applications. In addition to size and specification tables over 95 illustrations show valve sizes, types, and practical applications. A special section is devoted to Rockwell hypermatic lubricant, an innovation in automatic valve lubrication.

There's a JOHN CRANE Mechanical Seal To Meet Your Exacting Requirements....



Here is Industry's most widely used General Purpose end-face seal.

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Our trained field engineers are ready to work with you in selecting the best "John Crane" seal for your needs.

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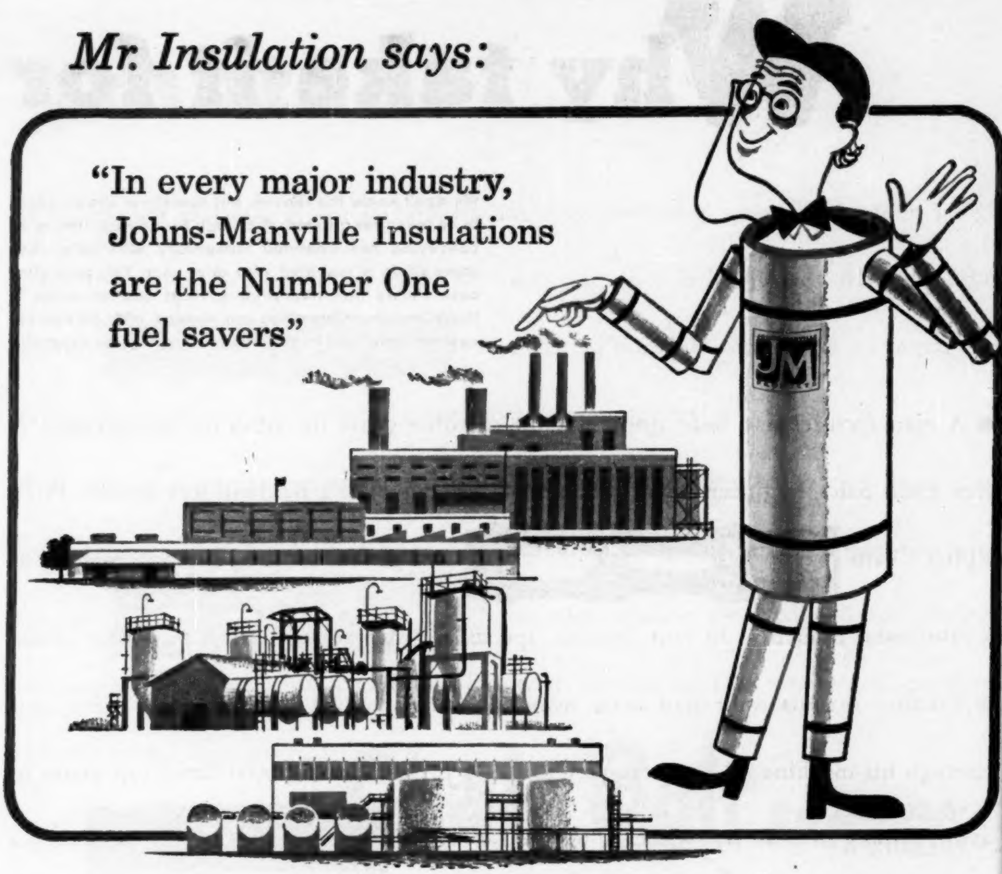


IN PLANTS with stacks or stills, tanks or towers, the story is the same—"Insulation by Johns-Manville" means the maximum return on your investment. There are two good reasons for this:

1. YOU GET THE RIGHT *MATERIALS*—From asbestos and other selected raw materials, Johns-Manville manufactures a wide range of industrial insulations for service from 400F below zero to 3000F above. If you need engineering advice in determining exactly the right one for your job, you can get experienced and authoritative assistance from your local Johns-Manville insulation engineer.

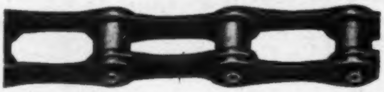
2. YOU GET THE RIGHT *APPLICATION*—Even correctly selected insulation needs proper application to permit it to serve at peak efficiency through the years. Here you can always count on J-M Insulation Contractors and their highly skilled mechanics. These organizations are trained in Johns-Manville application methods, and have generations of insulation experience behind them.

Why not get the complete picture? Call on insulation headquarters when your next job is in the planning stage. Just write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *first in* **INSULATIONS**

Why take it for

We don't know the reason, but somehow chains seem to be taken for granted. If a chain for driving, timing or conveying has operated reasonably efficiently, that same chain is specified year after year. Yet, case after case shows that important savings can be made if these important functions are viewed with an eye for cost reduction and improved performance. For example:

● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain  and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop®  he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain — ¼-inch pitch Baldwin-Rex No. 25  — and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain,  he not only cut his costs but the chain lasted far longer.

granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain.  The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

● To a manufacturer of construction machinery, who had been using cast manganese steel chains, a Rex Field Sales Engineer recommended the use of Rex Steel Chabelco Chains.  Since these chains are designed for efficient operation under dusty, dirty conditions, longer service life for both chains and sprockets at lower overall costs resulted.

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OF MILWAUKEE

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Because Rex Field Sales Engineers have all the resources of a complete chain line at their command, they can recommend without prejudice the exact type or size of chain that will deliver the most efficient performance at the lowest cost to you and your customers. You'll find it will pay you to consult with him regarding your chain application problems. Call or write your Field Sales Office, or mail the coupon.

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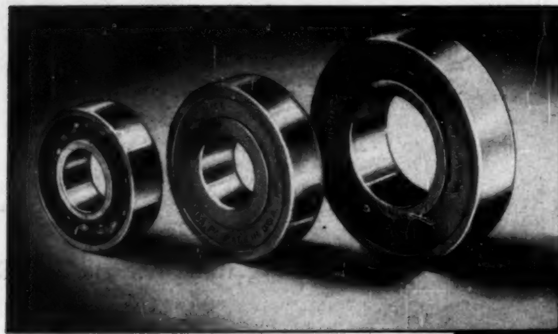

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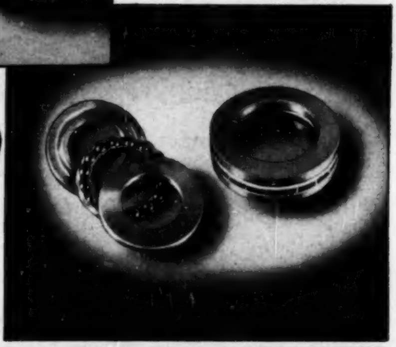
Series 1000 "ground" precision thrust bearings.



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NICE BALL BEARINGS

"Low cost" bearings can be "high quality" bearings. Quality is relative — a comparative measure of dollar value, and can be built into the most inexpensive product.

The Nice Line ranges from close tolerance, precision "ground" ball bearings to low cost "unground" ball bearings of inexpensive design and construction. For "top quality" at any price, specify Nice.

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1. Redrafting time saved. IBM reduces costly retracing in showing various wiring arrangements on *standard* plug-board panel drawings. Autopositives of the panel drawings are made. Then the draftsman simply adds the different wiring diagrams. Thus, print-making masters (with dense black photographic lines on a white, evenly translucent paper base) are produced in a fraction of the time complete retracing would require.

2. Blueprints can be reproduced directly. These prints are used to exchange design information between IBM's plants in Endicott and Poughkeepsie, N. Y. Whenever extra copies are needed for the shop—in either plant—there's no problem: Autopositives are made from the prints . . . and from these intermediates the required number of shop-prints are produced at uniform, practical machine speeds.

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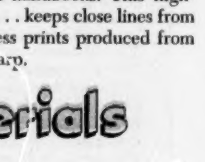
4. Old drawings are reclaimed. Some old IBM drawings which are discolored, weak in detail, and slow-printing are reproduced on Kodagraph Autopositive Film. This material does a superb job of cleaning up backgrounds . . . intensifying line detail—and IBM gets new, long-lasting intermediates which deliver sharp, clean prints *at top machine speeds.*



5. Halftones are copied. When limited runs are sufficient, IBM uses Autopositive Film to reproduce halftones and other printed illustrations in its instruction handbooks. This high-contrast material holds the finest line . . . keeps close lines from filling in. As a result, the direct-process prints produced from these intermediates are amazingly sharp.

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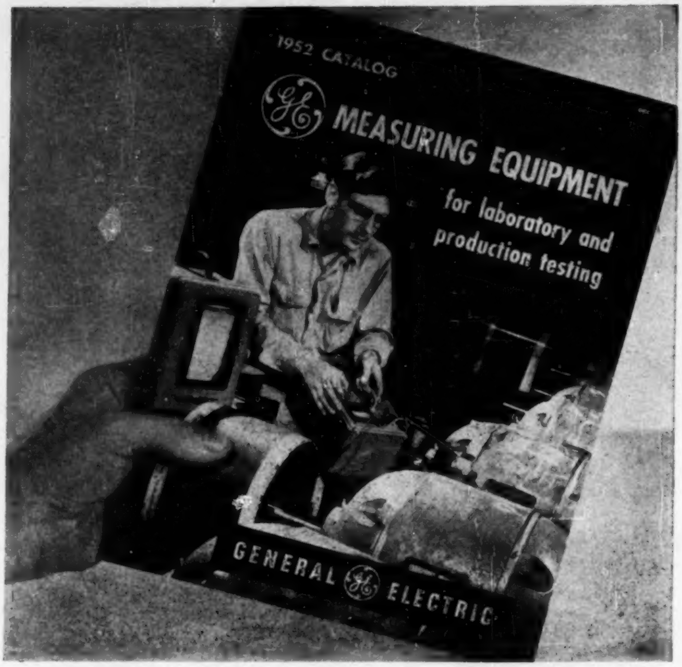

General Electric Offers Complete Catalog of Measuring Equipment

TABLE OF CONTENTS

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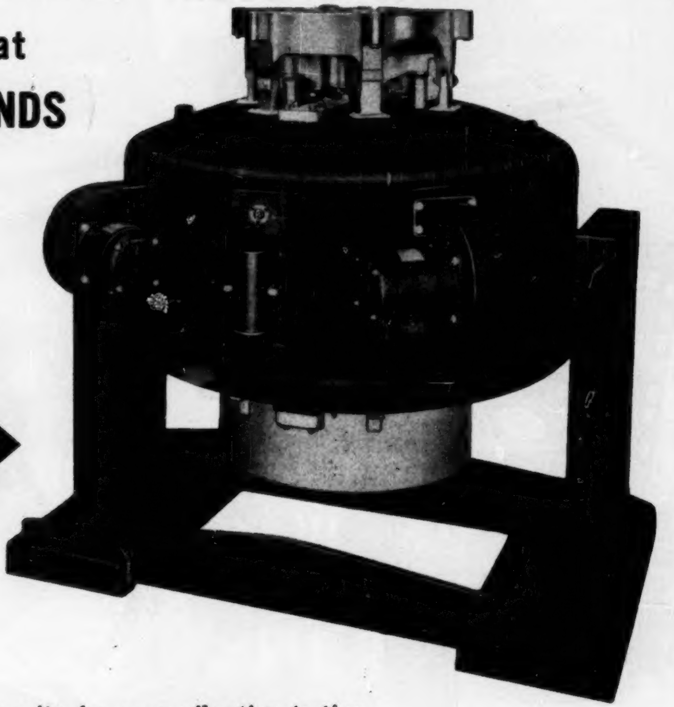

20 inch shake table!

15g at 100 lb table load!

Electrically interlocked control!

No foundation needed!

Here's heavy duty capacity for your vibration testing to military specification MIL-E-5272 and 41065-B

Vibration testing reveals *in advance* how your products will behave in service. It's a "must" for military equipment. This new MB model C-25 shaker, one of the largest developed, provides large "brute force" for meeting military vibration testing specifications. Rated at 2500 pounds continuous vector force, it has capacity to produce 15g with 100 lb table load or 20g with 58 lb table load.

An electromagnetic exciter, MB model C-25 features accurate, continuous, easy control of force and frequency. Electrically interlocking controls assure proper operation.

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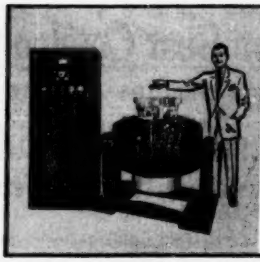
Make MB *your* headquarters for help and advice on vibration problems. You'll save yourself time and work. ***Write for new Bulletin No. 1-VE-4 on vibration exciters.***



MB's C-25 shaker with control panel. Available with built-in meter to read directly acceleration, velocity or displacement.

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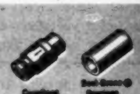

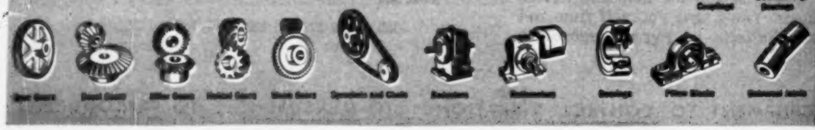

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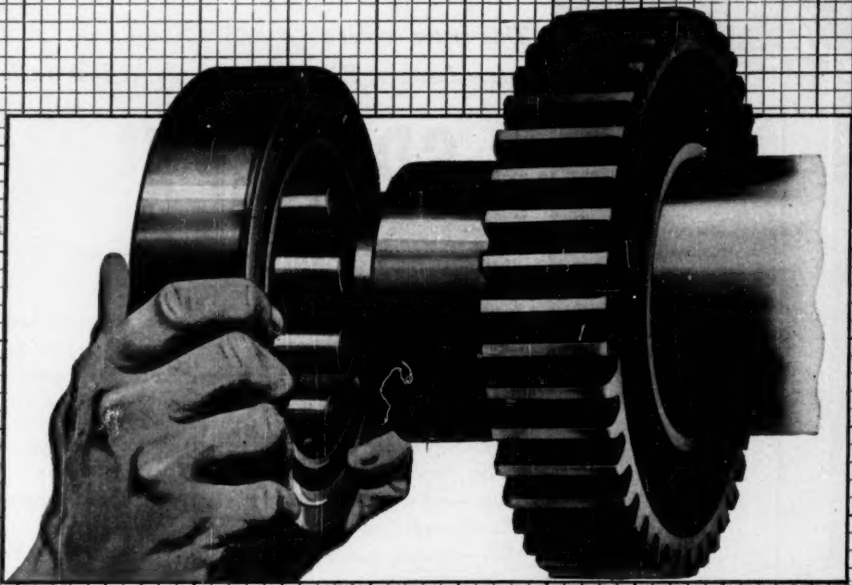
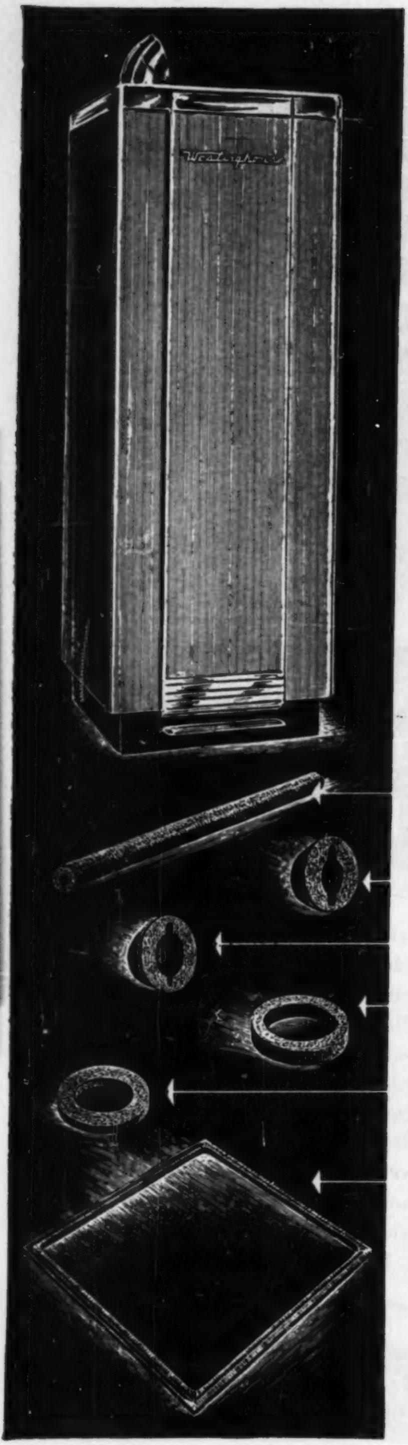


Simplify Shaft Design With HYATT HY-LOADS

The simplest way to mount an inner race on a shaft is by a press fit. Hyatt Hy-Load Roller Bearing inner races are made from carburizing type steels, heat treated to provide tough and ductile cores which safely permit relatively heavy fits. This fit is sufficient to hold the race in place without the use of accessory holding means, such as snap rings, lock nuts, or keys, and permits more simple and economical shaft design and construction. The press fit also locates the race properly and avoids the hazard of cocking or eccentricity which may occur with a loosely fitting race clamped endwise.

The holding of races on rotating shafts without auxiliary devices is just one of the features of Hyatt Hy-Load Roller Bearings. For complete information write for catalog 547. We'll be glad to send one to you. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



This water cooler
has a Longer, Better Life . . . works less each day

with **SPONGEX®**

CELLULAR RUBBER

Corrosion . . . deterioration . . . mechanical failure . . . repairs and parts replacement—an inevitable sequence wherever moisture condensation collects. It's a problem particularly troublesome in refrigerating equipment—but not in this Westinghouse water cooler!

Westinghouse has given its cooler a wardrobe of Spongex cellular rubber. Exposed cold surfaces—tubing, valves, even the waste water drain—are covered by custom molded Spongex parts. These Spongex parts not only prevent condensation but their insulating qualities increase refrigerating efficiency. For this cooler, Spongex means a longer, better, more efficient life.

The Westinghouse Wardrobe of SPONGEX

Tube insulator—
covers cold water tubing that supplies the drinking bubbler.

Regulator valve cap—
covers the cold surfaces of valve. Elasticity and flexibility of cap makes it easily removed for valve adjustment.

Water valve cap—
covers shut off valve controlling water flow to bubbler.

Basin drain insulator—
covers exposed end of the waste water drain.

Basin drain seal—
forms a water tight seal between bottom of the water cooler basin and top of the drain. The compressibility of Spongex compensates for variations in the clearance between basin and drain.

Door gasket—
forms an air tight seal for the door opening into the cold storage compartment. The gasket also seals off the insulating air space between the inner and outer panels of the door.

Perhaps Spongex can help better your product, too. We would be happy to hear from you.

The World's Largest Specialists in Cellular Rubber

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Let's talk turkey about tubing ...double-walled Bundyweld!

Bundyweld Tubing is double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

No other small-diameter tubing offers all the features of famous Bundyweld. For no other tubing is like it.

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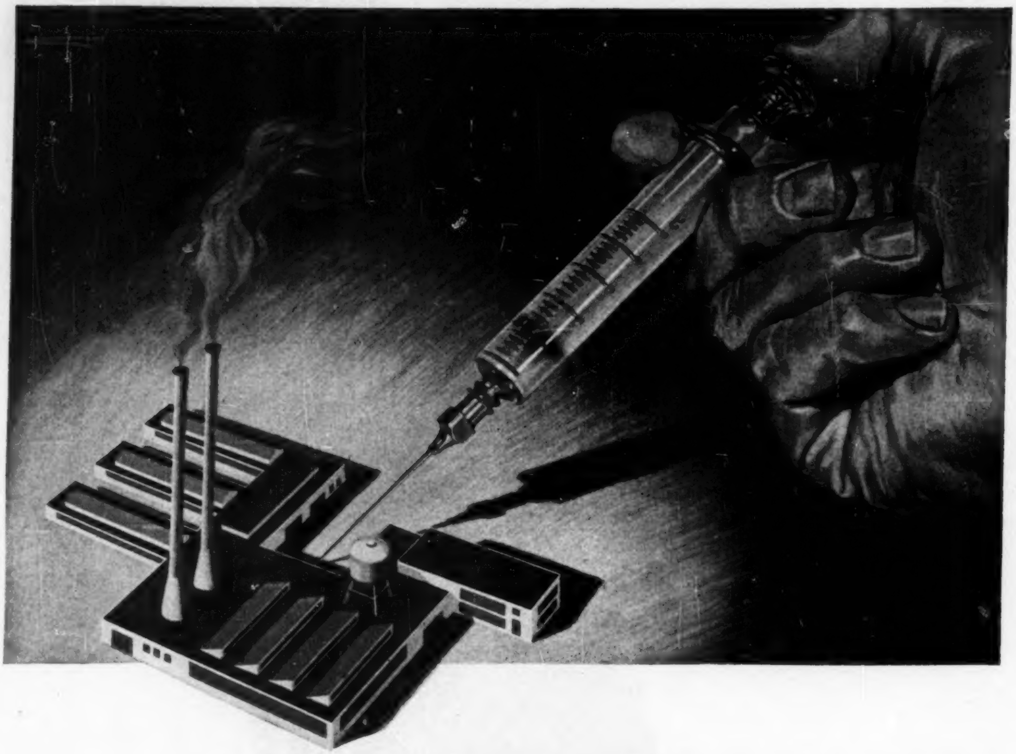

Vitamins That Make Production Grow

Perhaps, like many producers these days, you've found today's heavier demands are asking more from your equipment than it can produce.

Consider how one typical company injected new productivity into *its* operation:

This was a soap processor who needed extra production and new fuel economy for a process involving crude with a high salt content. Development of a specially-built still pot of economical clad steel eliminated need of multiple distillation . . . reduced fuel and maintenance . . . speeded up heating . . . ended corrosion . . . provided structural strength to withstand vacuum—*and cut first equipment cost, too.*

What makes this story significant is that it resulted from a progressive planning method followed by certain Equipment Builders.

These specialists bring leading engineers, designers, and materials suppliers into the planning of your equipment. Each factor affecting performance *is thought out by a specialist in that field.* And in such planning, you'll find these builders turning to Lukens for its knowledge of materials, as well as its wide range of low-cost clad steels.

Even with new equipment often difficult to get these days, we know builders who can recondition what you have for better performance, better profits. Write us today, explaining your need. Manager, Marketing Service, 402 Lukens Building, Coatesville, Pennsylvania.

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10 "magic tricks" EXPOSED!

• It seems like magic—the ways that Sylphon and Bridgeport bellows assemblies help solve design problems involving control of temperatures or pressures. The diagrams pictured here are typical—show you "how it's done."

And "doing it" is our specialty—has been for half a century. We've developed bellows assemblies that are used in practically every industry. They open and close valves, dampers, etc., absorb expansion, provide packless construction—have many more uses.

Whatever your bellows assemblies requirement may be, you can get expert help from us. You may have a problem similar to one we have solved for another customer. Or, you may need assistance in developing an assembly for a specific application. Let's talk it over.

Skilled craftsmen and complete production facilities assure bellows assemblies made *exactly* for *you*—that make important savings for you in time, trouble and money. Wide range of metals and sizes. Write for information. Ask for idea-filled Catalog XK-1200.

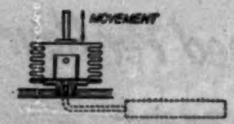

Fig. 1 Thermostatic Motor—This type of assembly is widely used in temperature regulators, etc., where a thermostatic charge is confined in the bellows and where a valve, switch, damper, etc. is to be operated in response to temperature changes.

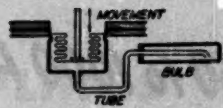

Fig. 2 Thermostatic Motor—This assembly is used where it is desirable to have the thermostatic charge confined outside the bellows and within a cup. May be used with or without remote bulb shown.

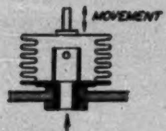

Fig. 3 Pressure Motor—Bellows assemblies are often employed to convert pressure effects into controlled movement. Fig. 3 shows such an assembly where the pressure is applied inside the bellows.

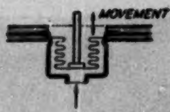

Fig. 4 Pressure Motor—This assembly differs from Fig. 3 in that the pressure is applied outside the bellows and within a cup.

Fig. 5 Expansion Chamber—This type of assembly is employed to absorb thermal or pressure expansion. With suitable heads, it would be used to serve as a reservoir for a liquid or gas. Example: Oil reservoir for electrical cable joint.

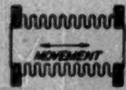

Fig. 6 Expansion Joint—Packless and leakless construction for expansion joints used to absorb thermal expansion of pipe lines carrying steam, water, etc. May be used to absorb vibration and provide flexible connection for other applications.

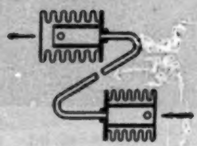

Fig. 7 Motion Transmission—Two bellows assemblies joined by a tube for hydraulic transmission of motion or power. Motive force applied may be either thermostatic or mechanical.

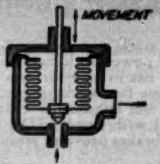

Fig. 8 Packless Construction—Illustrating packless valve construction. Same principle used to seal stem movement or adjustment in many types of apparatus.

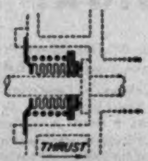

Fig. 9 Shaft Seal—Widely used for refrigeration compressors to prevent leakage around revolving shaft. Spring pressure holds nose of seal against shoulder on shaft. Another type used rotates with shaft and seals against stationary plate.

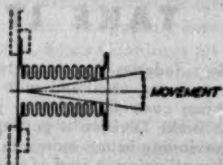

Fig. 10 Flexible Joint—Providing a means to seal a flexible joint or mechanical movement of levers, linkage, etc., against leakage where the movement must be conveyed outside an enclosure. Example: Operating stem of float switches, etc.

TEMPERATURE CONTROLS

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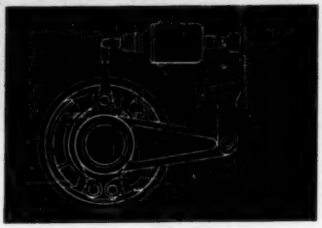

Railway track maintenance has to be quick, safe and positive. And the Pullman-Standard power track maintenance machines can crib, clean ballast, and tamp almost as many ties in an hour as a multiple-power-tool hand tamping gang can do in a day! These fast working machines need dependable brakes to stop and hold them in exact but continually changing work positions. And they have them! They're equipped with sturdy, TDA "P" Series Power Brakes. The simple design of these efficient brakes provides positive action—easy, low-cost maintenance.

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Modern industry is constantly working to produce machines that operate faster, safer and with greater efficiency. In many of these machines *controlled rotation* plays an important role. That's why TDA Brake Division is putting its 40 years' experience to good use in developing better, more efficient brakes to meet any type of industrial application. A staff of skilled brake engineers and TDA's modern production facilities stand ready to help you solve your specific braking problem. If one of a complete line of dependable TDA Brakes doesn't do the job, TDA Brake Division will design a brake to fit your needs. Simply mail the coupon below for complete information.

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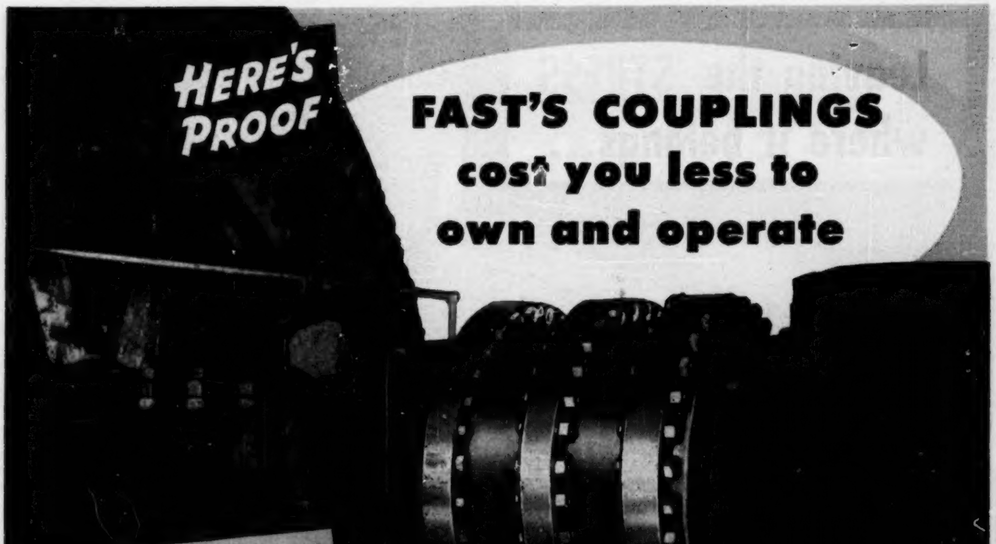

ON BILLET MILL SINCE 1923

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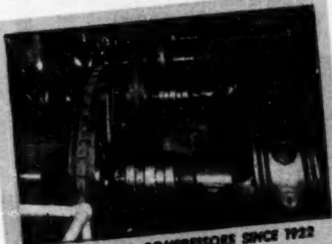

ON AMMONIA COMPRESSORS SINCE 1922

Fast's Couplings cost you less per year because they normally outlast the equipment they connect. That means their reasonable cost can be spread out over 20 years or more . . . assuring low-cost service without excessive maintenance costs!

Fast's basic design is *foolproof!* Instead of a perishable oil seal, Fast's are the only couplings to use a *permanent* metal-to-metal closure. Oil is always maintained at a safe level . . . whether the coupling is running or standing still . . . and dirt cannot get in. Fast's Couplings are compact, yet large enough to stand up under punishing service for 20 years or more!

When you specify Fast's Couplings, you get Koppers' valuable engineering service. In many cases where a special coupling appears necessary, Koppers engineers can modify a standard Fast's and save you money! Get the facts on Fast's Couplings. Mail the coupon for your copy of Fast's *free* Catalog today!

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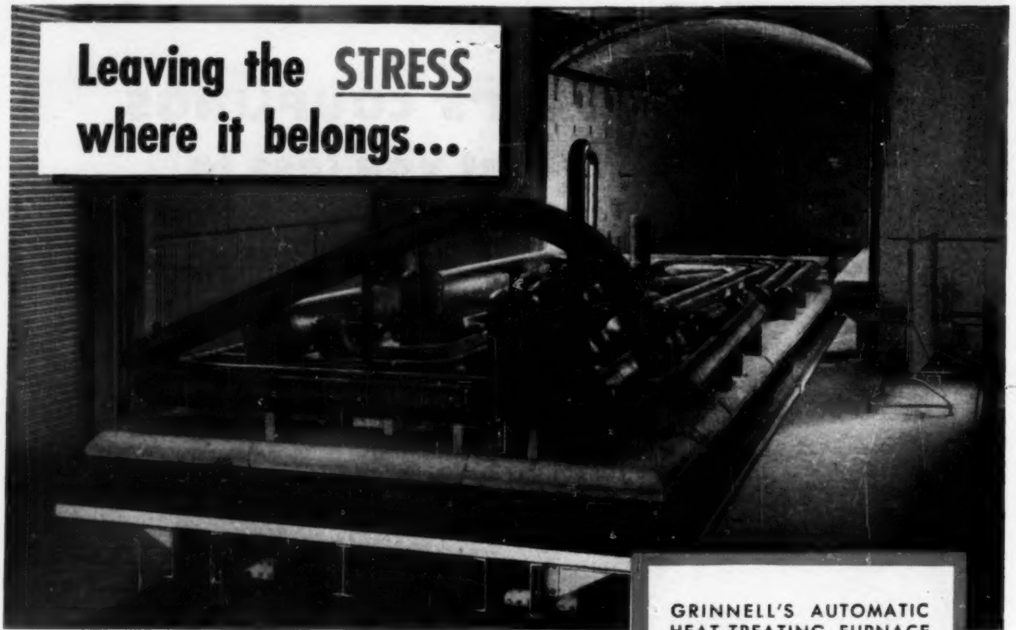


Leaving the STRESS where it belongs...

Stress relieving prefabricated piping with highly developed equipment and special techniques is one reason why exacting specifications are met with

GRINNELL PREFABRICATED PIPING

Grinnell received an order recently for stress relieving prefabricated piping to these specifications:—

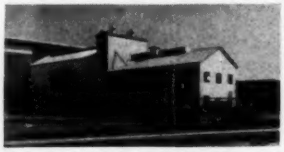
> "All fabricated pieces shall be normalized and drawn by heating to a uniform temperature of 1700°F (plus or minus 25°F). This temperature shall be maintained on a basis of one-half hour for each quarter inch of wall thickness of the heaviest pipe in the furnace charge followed by air cooling not less than 600°F. All pieces shall then be reheated to 1425°F and held at temperatures as above. In no case shall the time be less than 2 hours . . . Cool at a controlled rate not to exceed 200°F per hour until 600°F is reached . . ."

Grinnell, of course, met these specifications precisely. In fact, fabricating industrial piping today demands the *maximum* in versatility and precision.

Modern power plants, for example, need piping of heavy cross-sectional area and definite alloy composition to provide high temperature stability, resistance to creep and graphitization. Chemical and oil refining processes, on the other hand, must have piping of high chrome alloy to impart strength at high temperatures, resist corrosion, withstand impacts at low temperatures. Heat-treating often is the only answer — either to restore properties affected during fabrication, or improve original properties.

GRINNELL'S AUTOMATIC HEAT-TREATING FURNACE

performs with positive efficiency. This versatile stress-relieving unit, measuring 12 by 12 by 40 feet and using gas or oil or both as fuel, was designed to give full program control for the entire range of working temperatures. It provides instrument control of rate of rise in temperature of the charge, length of time for holding at the predetermined temperature level, and cooling rate. Two recording controllers are provided for the furnace and a separate 6-point recorder registers the temperatures of the charge simultaneously during the treating cycle.



Exterior View of Building

In heat-treating, as in everything else for piping, Grinnell has the experience and the costly equipment to fully protect large piping expenditures. That is why it will always pay you to call on Grinnell for *all* of your piping needs.

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WHENEVER PIPING IS INVOLVED

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Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
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Any Speed YOU NEED

WITH

GEARMOTOR

. . . because it is available in single, double or triple reductions, offering a range of speeds: 780 through 7.5 r.p.m. Motor rating from 1 h.p. through 60 h.p.—A-c or D-c. The motors and gear units are each self-contained and readily separated . . . gears in multi-reduction units may be inspected, without uncoupling from driven machine.

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GearMotoR conforms to the recommended standards of the American Gear Manufacturers Association and the National Electrical Manufacturers Association.

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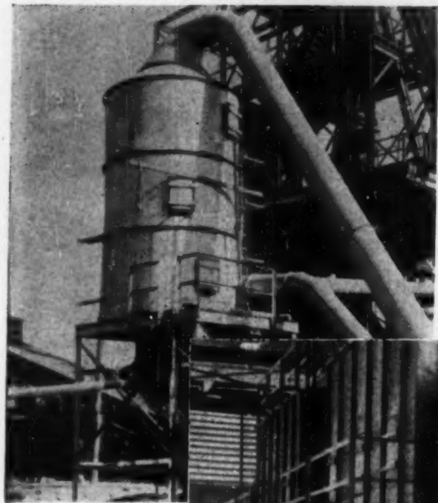
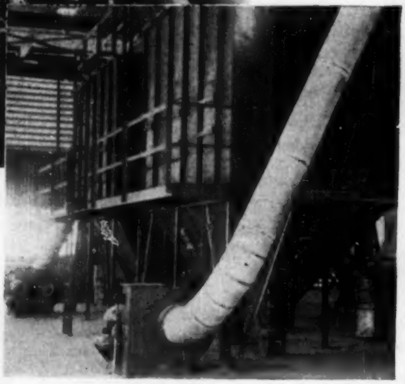
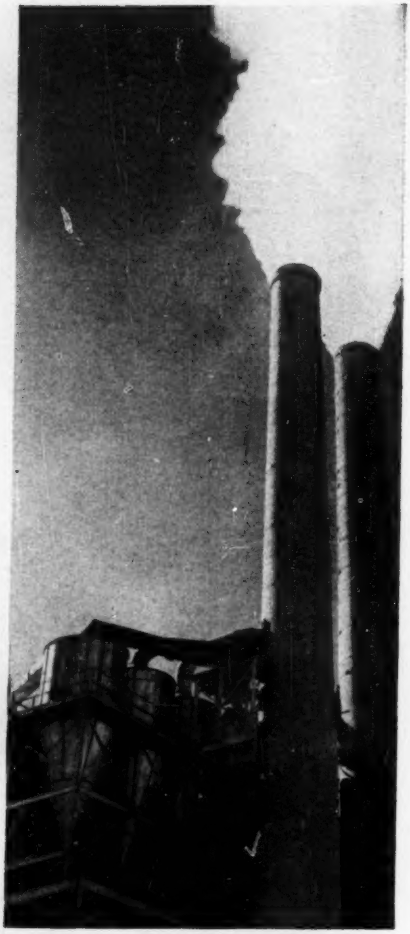


Hydraulic



Automatic Bag Type



Centrifugal

Whatever your need for dust or fume control, Norblo builds rugged, efficient equipment in Centrifugal, Hydraulic and Bag type collecting systems. These three types, frequently used in certain combinations, provide economical dependable control as required in smelting, rock products, chemical, milling and processing fields. Norblo Systems make outstanding records for high recovery with low operating and maintenance costs. Profit by Norblo 30 years' experience in heavy duty dust collection and Norblo development of these basic types of equipment. For good advice on dust or fume problems, consult Norblo.

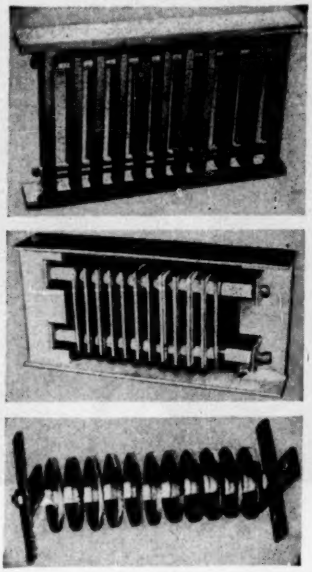
THE NORTHERN BLOWER COMPANY

Engineered Dust Collection Systems for All Industries

6421 BARBERTON AVE. • CLEVELAND 2, OHIO

How INCO HIGH-TEMPERATURE ENGINEERS SEEK THE ANSWER TO A PROBLEM

Inco High-Temperature Service is ready to assist you on metal problems at high heat with all its knowledge of high-temperature metal performance.



High-Temperature Test Racks are supplied in different styles or shapes when necessary for placing in the corrosive atmosphere. All are basically a selection of different metals — which are exposed simultaneously to the corrosive conditions.

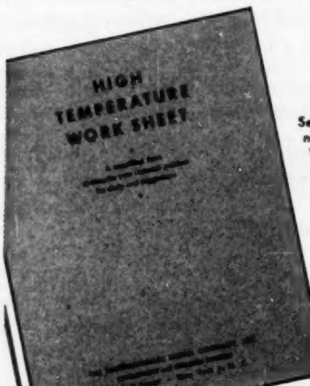
In laboratories at Bayonne, N. J., and Huntington, W. Va., creep tests measure the load-carrying ability of various alloys at temperatures up to 2100°F.

Other tests are constantly adding to the knowledge of how metals behave under varying degrees of heat and corrosive conditions. These laboratory studies are extended by field work. Investigation of metals serving in high-temperature applications reveals why some metals stand up where others fail. Corrosion is often the most important cause of damage and failures.

In field work Inco Engineers make use of High Temperature Corrosion Test Racks, shown above, to observe the effects of corrosive atmospheres. These carry a selection of different alloys which are placed right in the existing equipment to give a direct comparison of the various materials under actual service conditions.

After removal, the samples of various alloys are examined. The suitability of the alloys or the degree of damage is evaluated from the appearance of scale, the depth of attack, and other data derived from metallographic study and mechanical testing.

In your high-temperature problems, whether in present activities or in new projects, Inco High-Temperature Engineers will be glad to work with you. Let them send you the High-Temperature Work Sheet . . . to aid you in explaining your problem. Then see if Inco Engineers cannot help solve your difficulty.

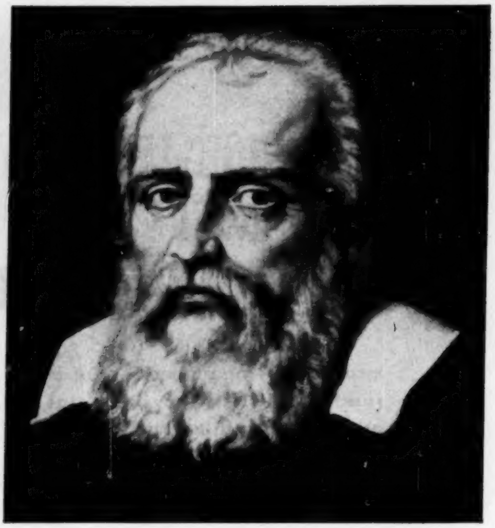


Send for your copy of this new High-Temperature Work Sheet; it simplifies gathering the full story of your problem.

EMBLEM OF SERVICE

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.



How many do

Whether you recognize the first three faces or not, we think you'll know the fourth one. There are thousands of these Taylor FULSCOPE* Controllers in service today, in almost every process industry from chemicals to milk, from petroleum to plastics.

A Taylor FULSCOPE Controller is a rugged, dependable air-operated instrument for control of temperature, pressure, flow, liquid level, density, load and humidity. It was the first controller on the market with completely interchangeable unit construction.

All parts are interchangeable, and every FULSCOPE case is drilled and tapped to hold the most complete set of control responses. Simple controllers can be converted into the most complex, if necessary, right in the field; repairs can be made quickly by your own instrument man.

*Reg. Trade-Mark

The six standard types of FULSCOPE Controllers fit almost any processing need:

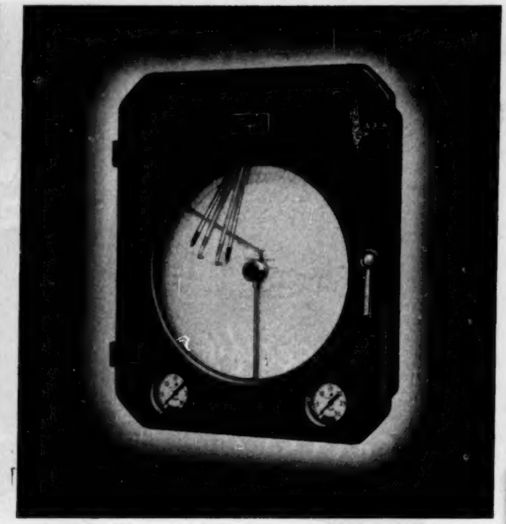
1. For simple on-off control on applications with small time lags and large capacities, regardless of load change, buy a *Fixed High Sensitivity* model.

2. For throttling control on similar applications, you need *Adjustable Limited Range Sensitivity.*

3. Throttling control where you have a wide range of time lags and capacities, infrequent or negligible load changes, calls for *Full Range Adjustable Sensitivity.*

4. Precision control under a wide range of time lags and capacities, with gradual, sustained load changes, calls for *Adjustable Sensitivity with Automatic Reset.*

5. Where there are momentary disturbances, but no sustained load changes, get *Adjustable Sensitivity with Pre-Act.*



you recognize?

6. To meet almost any control problem, get the Fulscope Controller with all three control effects: *Adjustable Sensitivity*, *Pre-Act* and *Automatic Reset*. It gives precision control on applications with a wide range of time lags and capacities, and sudden, sustained load changes.

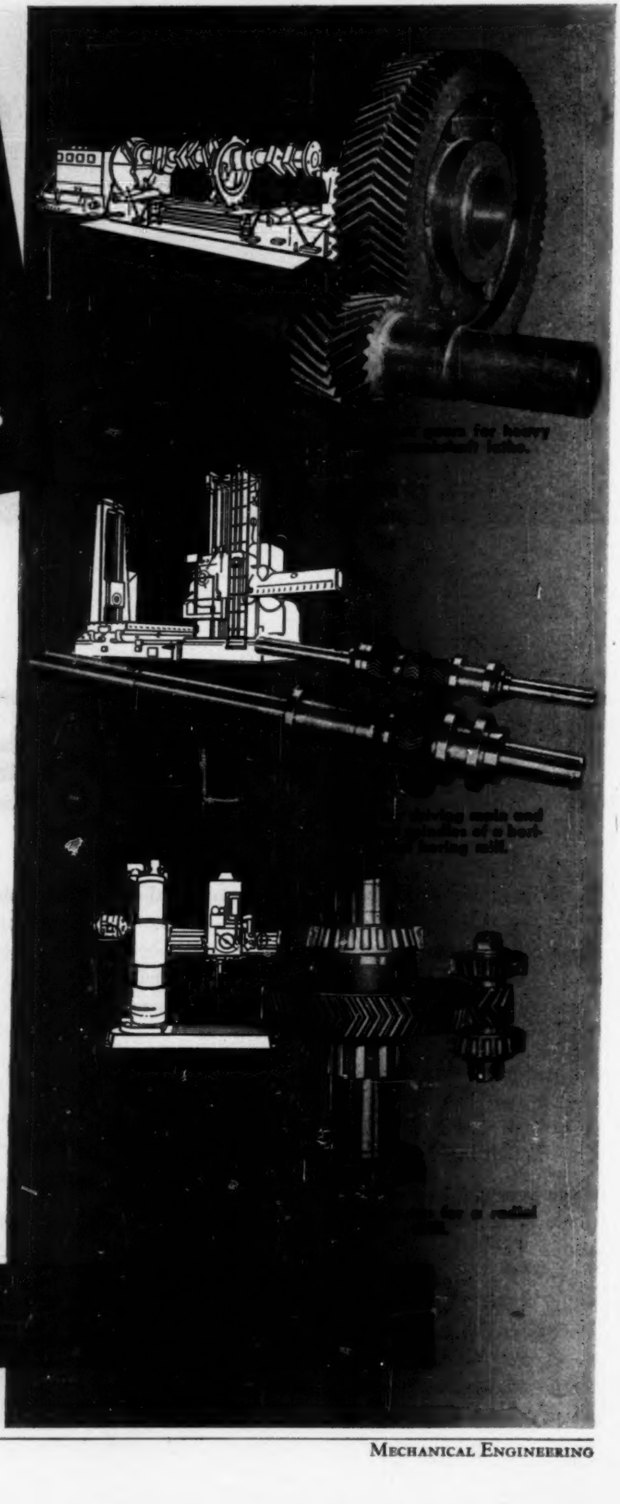
Ask your Taylor Field Engineer how Fulscope Controllers can help solve a big majority of your control problems, protect product quality and save money too. Write for Bulletin 98151.

Where pneumatic transmission is preferred, and particularly where graphic panels are wanted, ask about Taylor's revolutionary new three-part Transet* Control System too. Write for Bulletin 98097. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

Still wondering who the men are? All are founding fathers of the instrument industry. First on the left above is Torricelli, who made the first barometer. Next is Galileo, maker of the first thermometer, and then comes Boyle, who discovered Boyle's Law. The face on the right, of course, is the famous Taylor Fulscope Controller. It is found in practically every process industry.

Taylor's Centennial
ACCURACY FIRST SINCE 1851

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY



specify Farrel Gears

In many machine tools, *where accuracy is of primary importance*, Farrel herringbone gears are used to transmit a smooth, efficient flow of power to work or tool point.

The quiet, vibration-free performance and long life you can expect from these gears result from extreme accuracy of tooth spacing, contour and helix angle, and other qualities inherent in the Farrel-Sykes method of gear generation. They are made of the finest grade materials, in a complete range of sizes for any power capacity and any application.

Wherever power transmission must be smooth and vibrationless under all conditions of load and speed, *specify Farrel herringbone gears.* Information and engineering assistance available, without obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
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FB-698

BUSINESS IN MOTION

To our Colleagues in American Business . . .

For several years this space has been used to tell how Revere has collaborated with its customers, to mutual benefit. Now we want to talk about the way our customers can help us, again to mutual benefit. The subject is scrap. This is so important that a goodly number of Revere men, salesmen and others, have been assigned to urge customers to ship back to our mills the scrap generated from our mill products, such as sheet and strip, rod and bar, tube, plate, and so on. Probably few people realize it, but the copper and brass industry obtains about 30% of its metal requirements from scrap. In these days when copper is in such short supply, the importance of adequate supplies of scrap is greater than ever. We need scrap, our industry needs scrap, our country needs it promptly.

Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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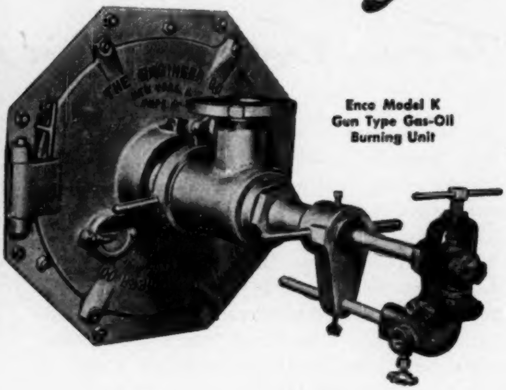
ENCO

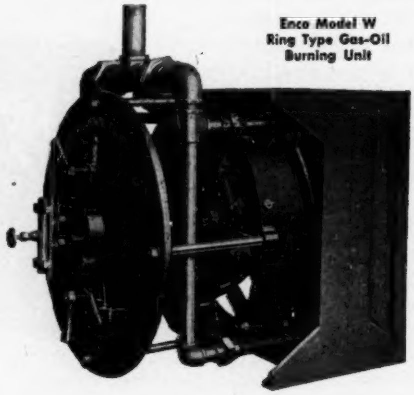
OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.



Enco Model W
Ring Type Gas-Oil
Burning Unit

ENCO

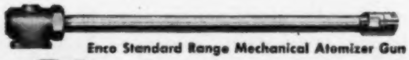
INTERCHANGEABLE ATOMIZERS

FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

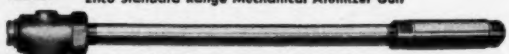
Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

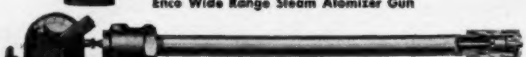
Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.



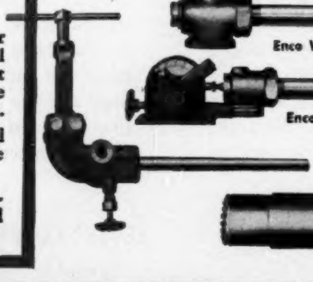
Enco Standard Range Mechanical Atomizer Gun



Enco Wide Range Steam Atomizer Gun



Enco Wide Range Mechanical Atomizer Gun



Enco Standard Atomizer
Gun Support

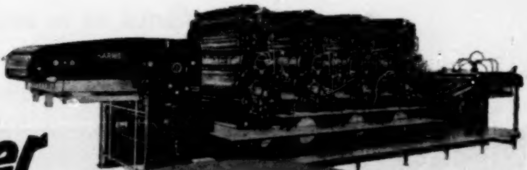
Enco Gas Burning Gun

EC-488

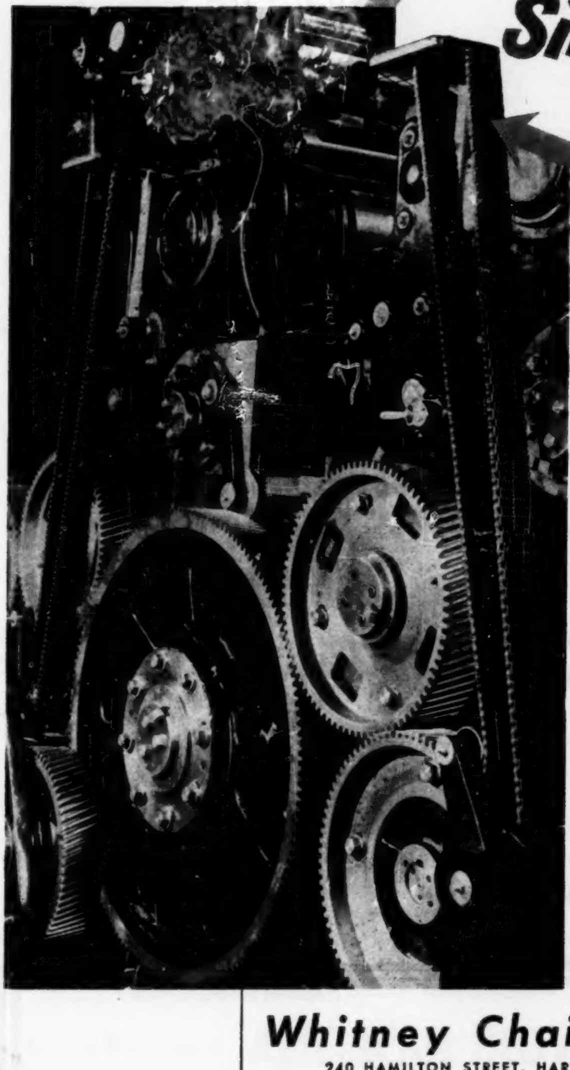
THE ENGINEER COMPANY 75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. RANKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

No Back Lash, Creep or Chatter



WHITNEY Silent Chain DRIVES



Transmit Smooth, Uniform Power,
Provide Perfect Timing,
Give Long Operating Life

Illustrated is the "Inker Drive" as used in the famous Harris Presses, manufactured by Harris-Seybold Co., Cleveland, Ohio.

In order to maintain perfect impressions, it is absolutely essential that this drive operate smoothly; back lash, creep or chatter cannot be tolerated as they would affect printing quality.

To obtain the perfect timing necessary and to get uniform power transmission for the all-important inking operation, Harris-Seybold Company uses Whitney Silent Chain Drives exclusively. Their experience over the past twenty years has proved conclusively that Whitney Silent Chain Drives transmit full power without friction or slippage . . . contribute to product reputation through real service performance.

In addition, Whitney Chain Drives are dependable drives . . . give long-lived service with minimum maintenance.

No matter what your drive problem, Whitney Chain Drives — Silent, Roller or Conveyor — *the all steel drives* . . . can help you simplify designs and cut power transmission costs.

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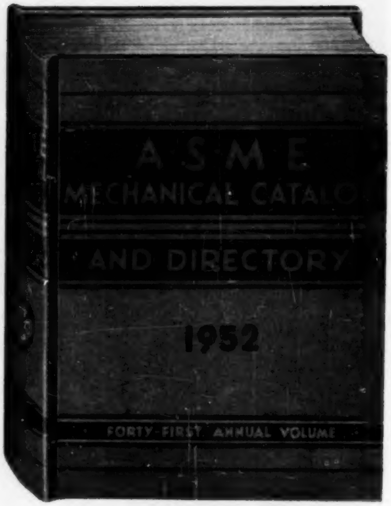


The American Society of Mechanical Engineers

29 West 39th Street New York 18, N. Y.

American Blower...a time-honored name in air handling

Richmond, Va., has a conveniently located American Blower Branch Office to provide you with data and equipment for air handling. You can reach American Blower in Richmond by calling 7-5630. In other cities, consult your phone book.

YARN ABOUT YARN . . .

A textile manufacturer was continually changing pulleys or setting the machine rate on his ring-spinning frames to fit the material that worked at the lowest speed. He'd heard about American Blower Gÿrol Fluid Drives and decided to try them. Results were amazing. Gÿrol Fluid Drive permitted a higher output within safe limits of the material, allowed spinning frames to start gradually with less yarn breakage. For your business, wouldn't smooth power transmission and adjustable speed control be a distinct advantage?

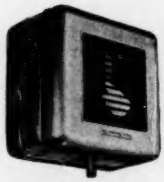
FOOD FOR THOUGHT . . .

Those magnificent new supermarkets springing up around the country are just as comfortable as they are modern. Many use American Blower Ventura Fans for ventilation the year round, and Venturafin Unit Heaters for winter heating. They meet a twofold requirement. First, both units are beautifully styled to harmonize with modern designs. Second, both units are quiet-operating — a necessity in modern stores. Our nearest branch office will be glad to furnish price and delivery data.

FUMES, VAPORS, GASES . . .

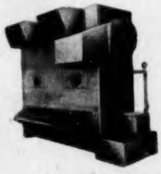
In addition to a wide range of standard ventilating equipment for industry, American Blower also offers special fans to handle corrosive gases, fumes, vapors. Some corrosive gases are vital to process work and must be circulated in the system with corrosion-resistant fans. Gases and fumes which affect the health and comfort of employees must be removed. There is an American Blower corrosion-resistant fan that will meet your requirements for those special applications in the process industry.

Whatever your needs, American Blower heating, cooling, drying, air conditioning and air handling equipment will improve over-all comfort and efficiency in your business. For data, phone or write our nearest branch office.

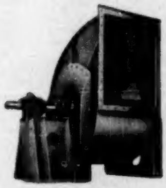


Unit Heaters

Ventura Fans



Air Conditioning Equipment



Industrial Fans

Utility Sets

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary corporation

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • ACME CABINETS • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON

PACIFIC-WESTERN HIGH-SPEED UNITS

Examples of the gearmaker's finest art!

Many Pacific-Western high-speed units hold positions of grave responsibility, as drives for test equipment, wind tunnels, pumping stations, etc. They merit the finest art of the West's oldest and largest gearmaking organization . . . and it is significant that no Pacific-Western high-speed unit has ever failed to do the job for which it was designed. This includes high-speed units that have been on continuous duty for 20 years!

5117

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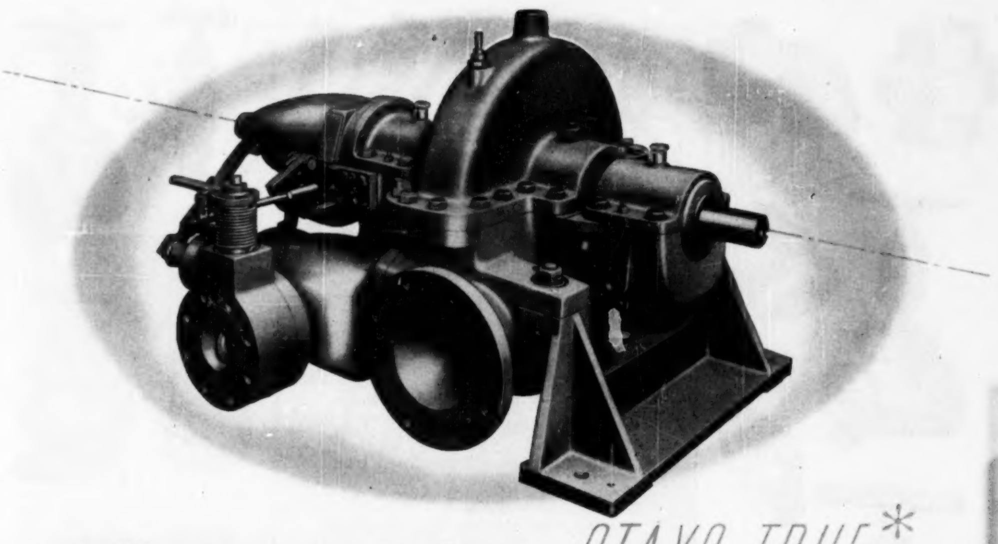
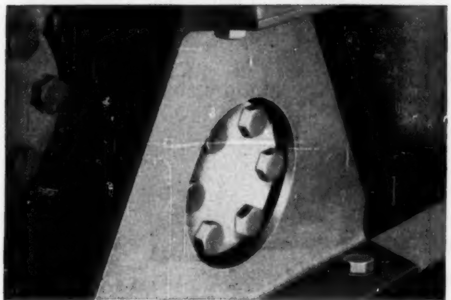
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B.C.



Alignment that STAYS TRUE* when the heat's on!



Three-Way Centerline Support

* The Type E method of support allows three-way freedom of expansion and contraction without disturbing the alignment of the rotor shaft. The governor end is mounted on a strong but flexible channel beam to permit axial expansion. At the shaft-coupling end, a unique keyed support connects to the turbine near the shaft centerline to permit lateral expansion; and a vertical kingpin transmits thrust from the expanding steam pipes directly to the foundation and not to the turbine. The casing is free to move vertically with expansion or contraction.

Heat expansion can't disturb Type E alignment. The operation of driven equipment is easier, more dependable —installation costs are reduced. Westinghouse unique *three-way centerline support* keeps alignment perfect with the driven machine. Strong supports at both the governor and exhaust ends are supplemented by a vertical kingpin that transmits lateral thrust to the foundation. Hot or cold —for constant operation or instant stand-by power, you can depend on the Type E Turbine to "Stay True"!

There are other cost saving advantages, too. Dual protection against overspeed, weatherproof bearing seals, corrosion-resisting gland zones, floating movement of governing and trip linkage, and parts interchangeability between wheel sizes are just a few.

For the full story ask your nearby Westinghouse Steam Specialist for the Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-50520

YOU CAN BE SURE.. IF IT'S
Westinghouse

TYPE E Turbines


Walworth manufactures a complete line of Gate, Globe, Angle, Check, and Lubricated Plug Valves, made of Stainless Steel, Steel, Iron, Bronze, and Special Alloys in a wide range of sizes and temperature-pressure ratings.
Fittings of steel, iron, and bronze are also manufactured in all conventional types and sizes.
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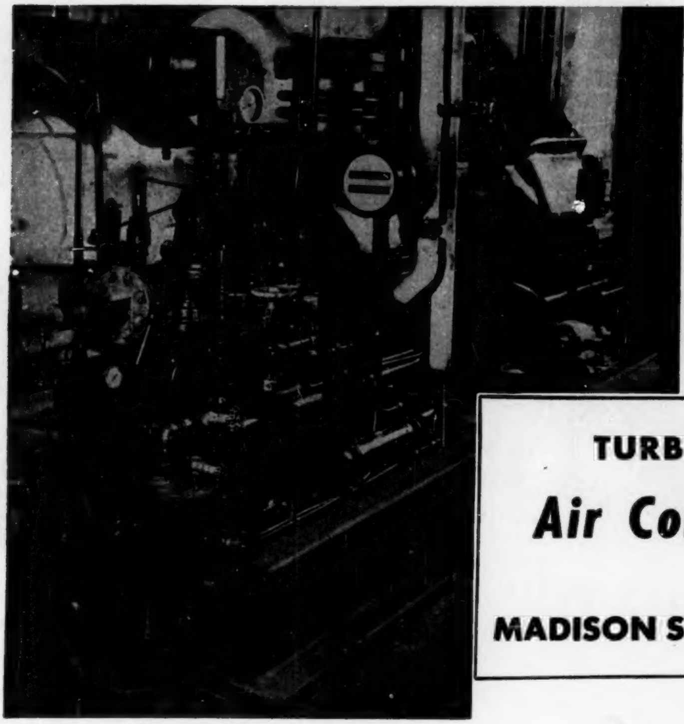
The TERRY TURBINE



TURBINES FOR

Air Conditioning

AT

MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.


Your welders will seem like
Siamese Twins
When they use Midwest Welding Fittings, your welders will turn out so much more work that they'll seem like Siamese Twins. The reason? . . . The exceptional accuracy and uniformity of Midwest Welding Fittings enable your welders to spend more time welding and less time in preparation.
MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGNS AND REDUCE COSTS
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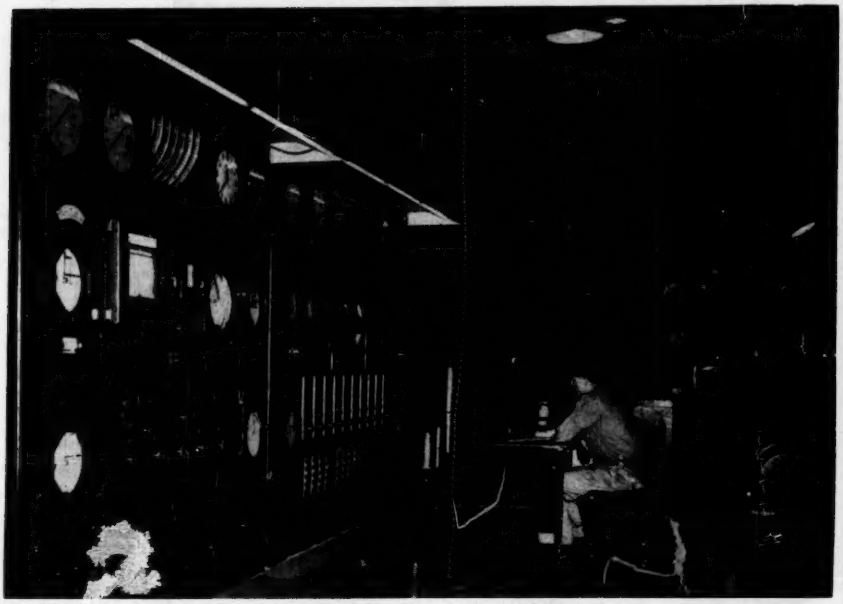
THE MUNICIPAL ELECTRIC PLANT

of MUSCATINE, IOWA

Knows the value of

Automatic Control



Republic automatic boiler control and instrument panels at Muscatine Municipal Electric Plant

In 1941 the Municipal Electric Plant at Muscatine, Iowa, installed a modern 100,000 lb. per hr. steam generator. In 1948 a second boiler rated at 160,000 lb. per hr., 650 psi. was added.

In any steam electric generating plant, electric power rates and steam costs go hand-in-hand. Low steam cost however, is not the result of efficient boiler design alone. To realize all the operating advantages of these modern boilers, each was equipped with a Republic automatic combustion and feed water control system at the time of installation.

The installation of Republic automatic controls on your boiler or (boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hours a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

REPUBLIC FLOW METERS CO. • 2240 DIVERSEY PARKWAY • CHICAGO 47 ILLINOIS

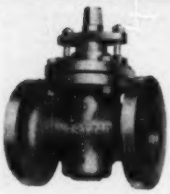
WE MAKE ALL TYPES OF PLUG VALVES

For *ALL* Kinds of Services
In the Right Metals for Your Needs

HOMESTEAD CAM-SEALD
(dry seat)

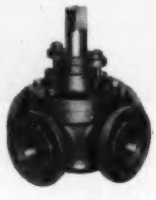
HOMESTEAD
Lever-Seald
Quarter-Turn
PLUG VALVE

HOMESTEAD-REISER
(lubricated)

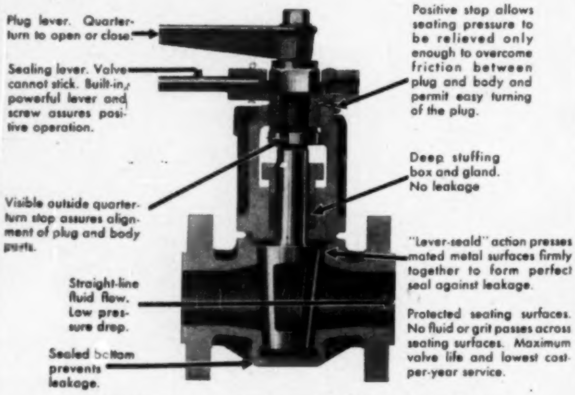


Straight-way—
Flanged or Screw Ends

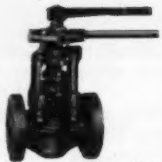
Three-way—
Screw or Flanged Ends



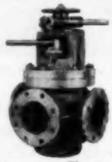
Four-way—
Flanged or Screw Ends



Sectional View — Homestead Lever-Seald Valve — Closed Position



Straight-way— Flanged or Screw Ends



Three-way— Flanged or Screw Ends

Four-way— Flanged or Screw Ends

Straight-way—
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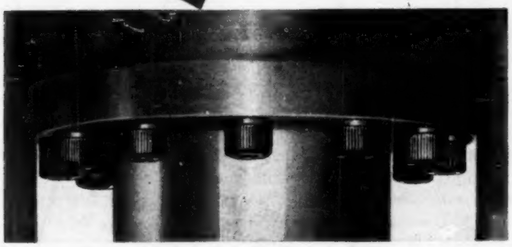

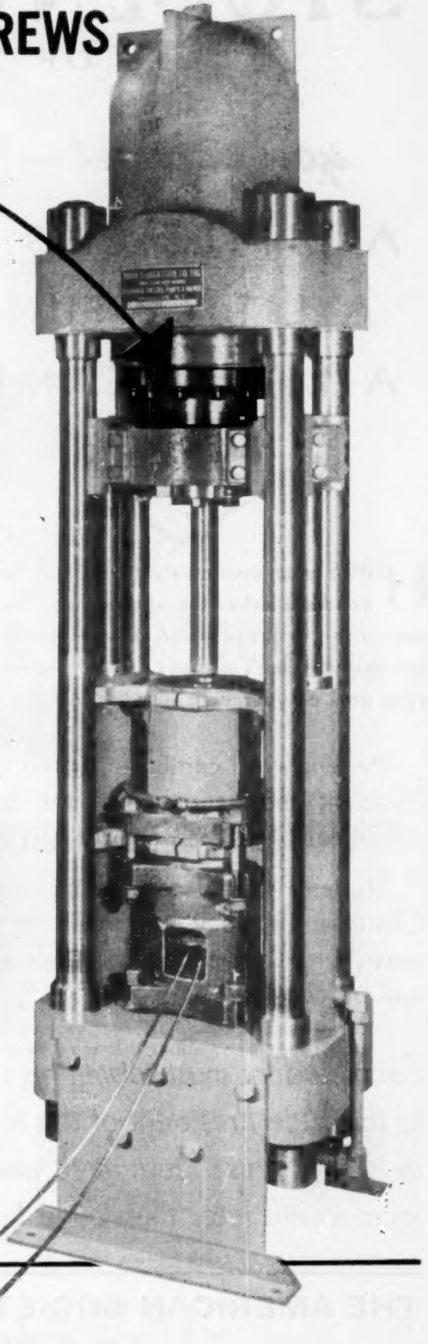

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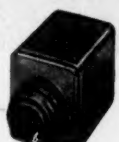

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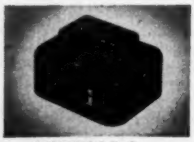

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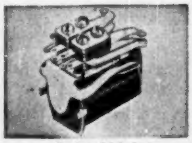

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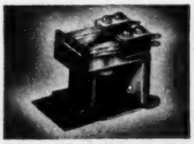

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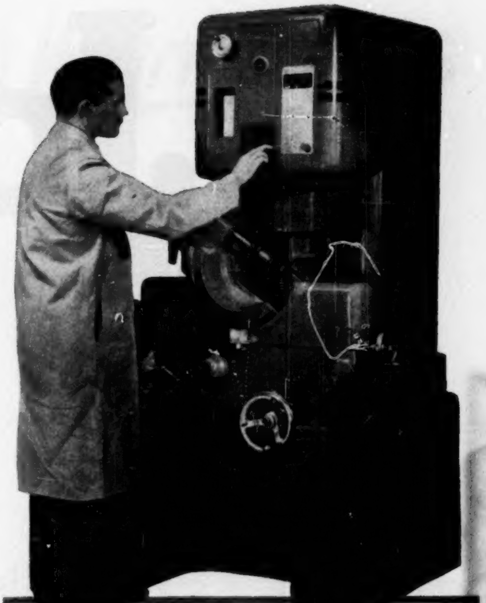

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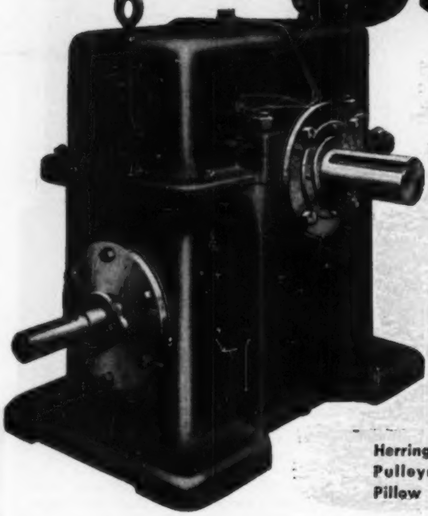

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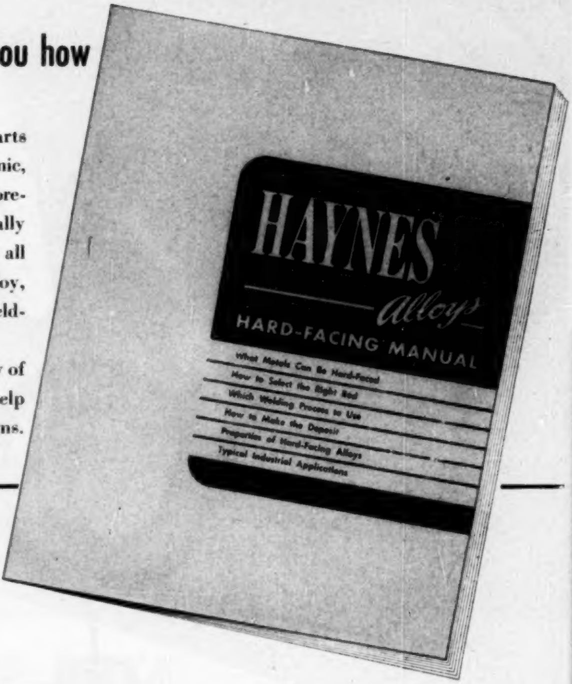

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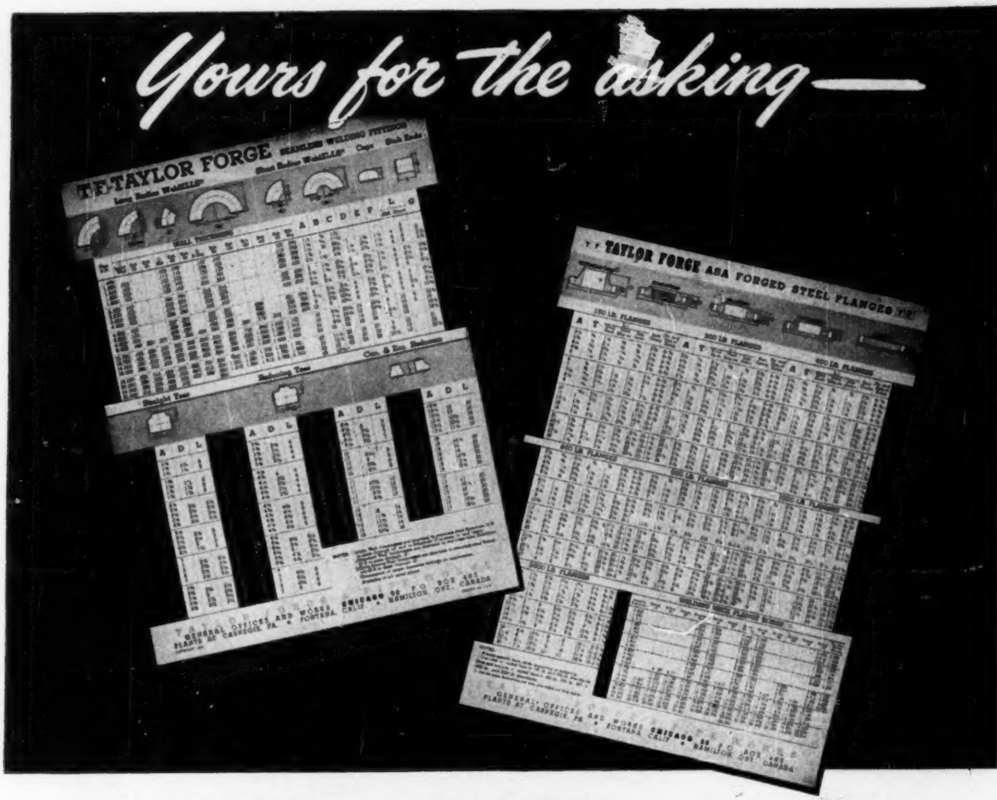

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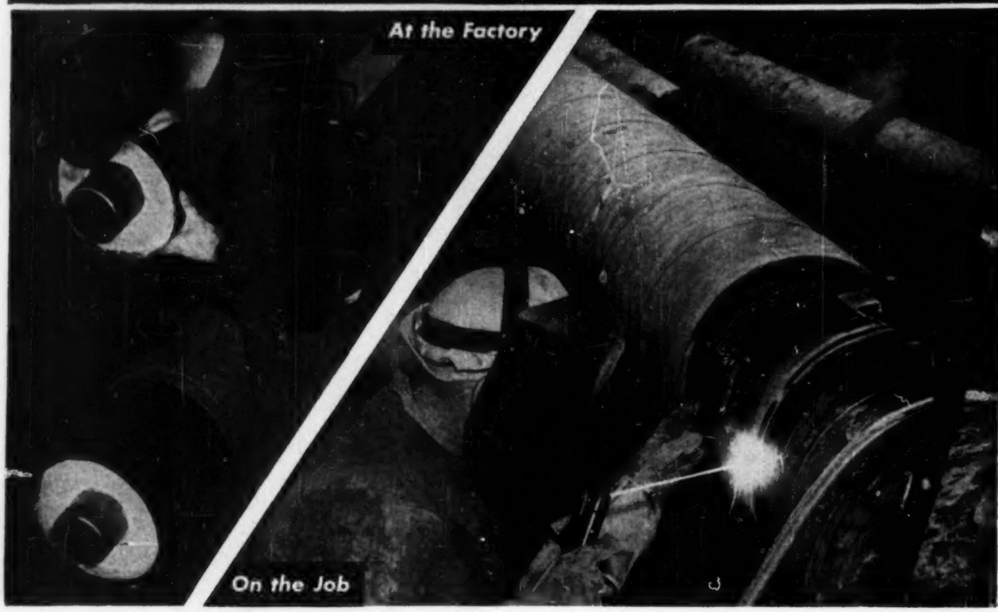

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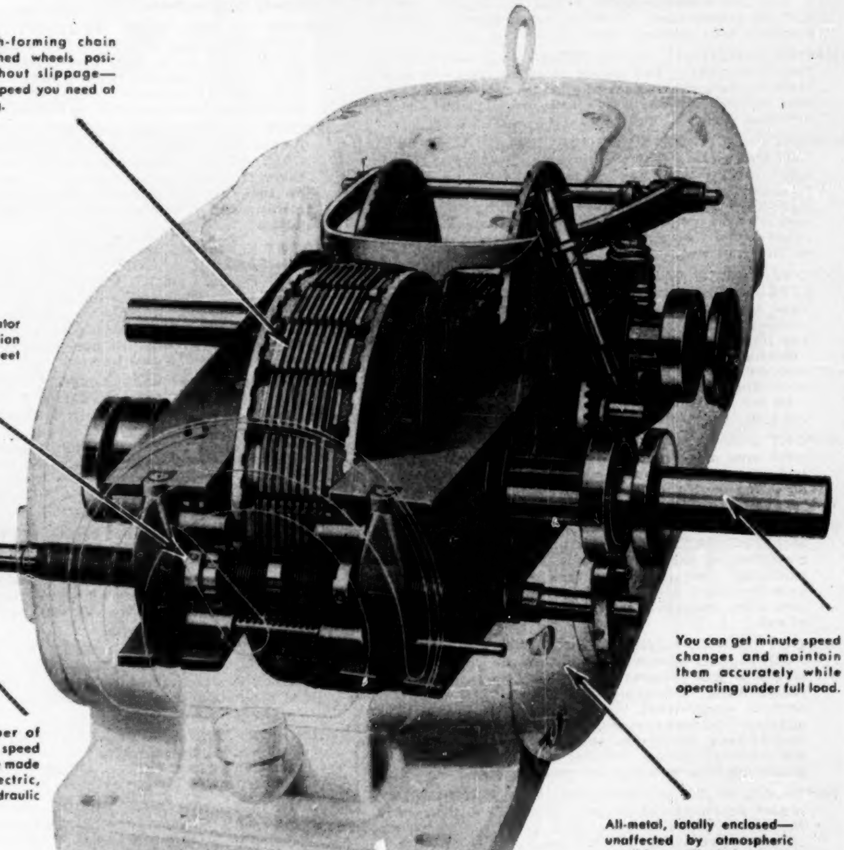

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These 1946-1947 CUTTER RESEARCH REPORTS were reprinted to fill requests for the valuable data and information they contain

REPORT 1—MCD 7/46. FACE MILLING 40,000 PSI "MEEHANITE" CAST IRON. Tests were made to determine the tool life when varying the feed per tooth on an old, non-rigid vertical spindle milling machine and to compare these results with those obtained on a new machine.

REPORT 2—MCD 7/46. WIDTH OF BAR EFFECTS TOOL LIFE. These tests were carried out to determine tool wear, tool life, and power requirements when face-milling "Meehanite" Cast Iron, 197 BHN, 40,000 psi of 1, 2, 3, and 4 inches width of cut respectively, with a K2S carbide-tipped, inserted single-tooth, 9.06-inch diameter face-milling cutter.

REPORT 3—MCD 8/46. FLYWHEEL EFFECT—NEW MILLING MACHINE. The object of these tests was to determine the performance of a single-tooth cutter when face milling without a flywheel and with flywheels of different sizes.

REPORT 4—MCD 8/46. FLYWHEEL EFFECT—OLD MILLING MACHINE. Tests were run to determine tool life when milling with and without a flywheel. The performance of a single-tooth carbide-tipped face-milling cutter was investigated when face-milling "Meehanite" cast iron on an old, non-rigid vertical-spindle milling machine, and on a new, more rigid, horizontal-spindle milling machine.

REPORT 5—MCD 9/46. PERIPHERAL CUTTING-EDGE EFFECT. Tests were conducted to investigate the tool wear, tool life, and power consumption when using peripheral-cutting-edge angles (pcea) of 0, 15, 30, 45, and 60 degrees when face-milling 40,000 psi, 190 BHN, "Meehanite" cast iron with a single, carbide-tipped inserted tooth, 9-inch diameter face-milling cutter operating at a depth of cut of 0.100 inch, a feed of 0.010 inch per tooth, and cutting speeds ranging from 290 to 940 fpm.

REPORT 6—MCD 9/46. RELIEF ANGLE EFFECT. These tests were performed to determine tool wear, tool life, and power consumption when varying the relief angles on 0 degree and 45 deg peripheral cutting-edge angle (pcea) face-milling cutters.

REPORT 7—MCD 10/46. POWER REQUIRED FOR FACE MILLING CAST IRON. Data here presented resulted from tests of three grades of cast iron and six grades of malleable cast iron were face milled with sintered-carbide-tipped and high-speed-steel face-milling cutters when operating at various speeds, feed, and depth of cut.

REPORT 8—MCD 12/46. EFFECT OF MATERIAL ON TOOL. Tests were made to determine how the properties of a tool material affected its performance when face-milling "Meehanite" 197 BHN, 40,000 psi cast iron with a single-tooth 4¼ inch diameter face-milling cutter. The tool materials were high-speed-steel, cast-non-ferrous, and several grades of sintered carbide. An old vertical-spindle milling machine which lacked proper rigidity was used for these tests.

REPORT 9—MCD 1/47. BRAZING AND GRINDING. This report describes the practice used at the University of Michigan when brazing and grinding of sintered-carbide tips of milling-cutter teeth.

REPORT 10—MCD 3/47. AXIAL RAKE ANGLES VS. TOOL LIFE, TOOL WEAR & POWER. These texts were performed to determine the effect of axial rake angle on not only the axial thrust, but also the tool life, type of tool wear, and power requirements.

REPORT 11—MCD 4/47. RADIAL RAKE VS. TOOL LIFE AND POWER. Tests were conducted to investigate the tool life and the power consumption when using radial rake angles of —14, —7, 0, plus 7, plus 14, plus 21, plus 28 degrees when face-milling 40,000 psi "Meehanite" cast iron, 190 BHN with a carbide-tipped single-tooth, inserted, 9 inch diameter face-milling cutter at a depth of cut of 0.100 inch, a feed 0.010 inch per tooth and cutting speeds ranging from 510 to 1260 fpm.

REPORT 12—MCD 6/47 and MCD 7/47. CAST IRON VS. TOOL LIFE AND POWER. Nine types of cast irons, varying from 143 to 229 BHN, were cut with two grades of sintered-carbide, 44A and K2S, to investigate the tool wear, tool life and power requirements. A single-tooth, carbide-tipped inserted blade, 9-inch diameter face-milling cutter was used with a depth of cut of 0.100 inch, a feed per tooth of 0.010 inch and cutting speeds ranging from 290 to 1260 fpm.

REPORT 13—MCD 10/47. RIGIDITY VS. TOOL LIFE. Conditions which affect tool life, such as rigidity of the spindle and work, were investigated by using an old No. 3 vertical-spindle milling machine to face mill an inch wide "Meehanite" cast iron with a single-tooth sintered-carbide face-milling cutter.

REPORT 14—MCD 4/48 and MCD 5/48. EFFECT OF AXIAL RAKE ANGLE WHEN FACE MILLING SAE 4130 CAST STEEL. These face milling tests were undertaken to determine the effect of various axial rake angles on tool life, power and surface roughness when face milling SAE 4130 cast steel with sintered-carbide tipped cutters.

REPORT 15—MCD 7/48. EFFECT OF TOOL PROFILE ON SURFACE ROUGHNESS, TOOL LIFE, TOOL WEAR AND POWER REQUIREMENTS. Three tooth profiles most often used and generally accepted in the metal cutting industry for giving good tool life, were tested for the purpose of determining their influence on surface finish, tool life, and power requirements when face milling duplexed cast iron.

REPORT 16—MCD 8/48. EFFECT OF TYPE OF MILLING MACHINE ON TOOL WEAR AND TOOL LIFE WHEN FACE MILLING MEEHANITE CAST IRON. These tests were made to determine whether or not the design of a milling machine, which affects its rigidity, will alter the performance of a given cutter as measured by tool life tests. The screw feed and the hydraulic feed designs were also compared by tool life tests when face milling "Meehanite" cast iron.

REPORT 17—MCD 9/48. PERFORMANCE OF CUTTING MATERIALS MILLING CAST SAE 4130 STEEL WITH 4 INCH AND 9 INCH FACE MILLING CUTTERS. This report presents the results of tests made to determine if tool materials have the same relative cutting speeds when face milling cast SAE 4130 steel as when cutting cast iron.

REPORT 1—MCD 1/47. EFFECT OF AN ADDED FLYWHEEL ON TANGENTIAL AND TORQUE FORCES. The test was made for the comparison of oscillograms of tangential and torque forces when milling with and without flywheels.

REPORT 2—MCD 2/47. FORCES VS. CUTTING POSITION. This report covers a study of the cutting forces vs. the position of the workpiece in respect to the horizontal center line of the cutter.

REPORT 3—MCD 2/47. FORCE VS. CUTTING SPEED 1020 SAE STEEL. Research was undertaken to compare the cutting forces with a variation in speed.

REPORT 4—MCD 5/47. FORCE VS. CUTTING SPEED NE 8630 STEEL. Tests were undertaken to compare the cutting forces with the variation of speed.

REPORT 5—MCD 5/47. FORCE VS. CUTTING ANGLES 1020 SAE STEEL. This research was undertaken to study the cutting forces while milling 1020 SAE steel with a change in the rake angle combinations.

REPORT 6—MCD 9/47. TOOL LIFE VS. WORK POSITION MILLING NE 8630 STEEL. The purpose of this test was to compare the tool life time with cutting forces while cutting NE 8630 steel for three different work positions.

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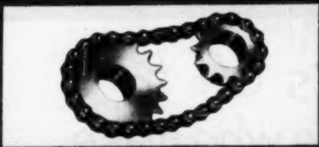

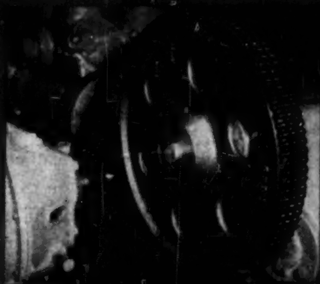

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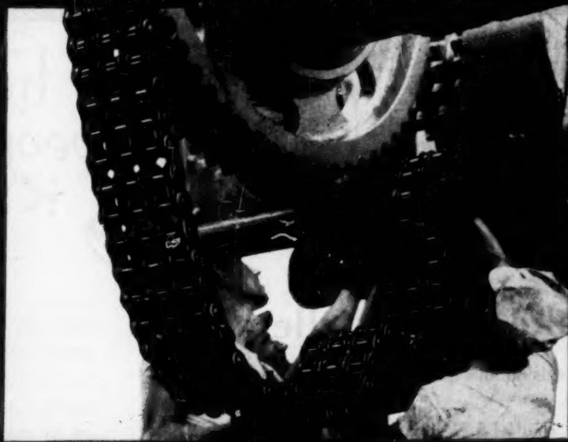

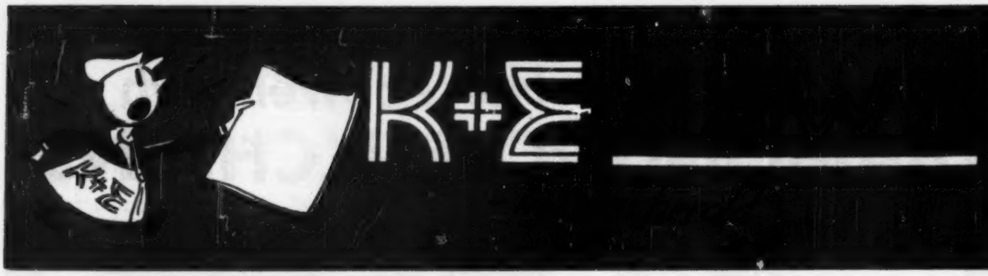

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You just don't get to be that fine in one generation. There are a number of K&E employees who have been around for about a half a century, and there are

MOST K&E WORKERS MUST HAVE CUT THEIR TEETH ON K&E SLIDE RULES

some 150 employees who have been there for a quarter of a century or more. This latter bunch of kids, as well as the young sprouts who have been there only 20 or 15 years, have inherited the K&E feeling for doing things the good, old, exciting, honest way.

But don't get the idea that there is any moss on K&E. An outfit that has thrived this long has to have the knack of remaining perennially young and of keeping ahead of the pack.

The first factory built by Keuffel & Esser, in 1880.

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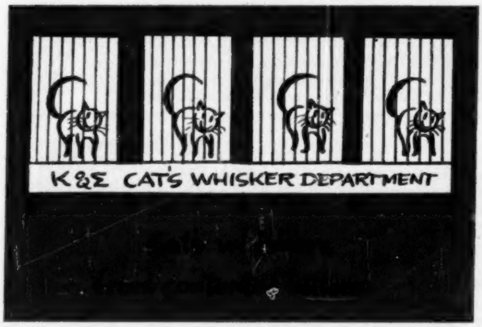
When K&E coined the phrase "Partners in Creating," they of course meant not themselves but their products. And it's true that K&E products have been in with engineers, scientists, draftsmen and architects on the

The K&E trade mark for decades, and the more modern one adopted in recent years.

creation of most of the big man-built wonders of the world for over 4/5 of a century.

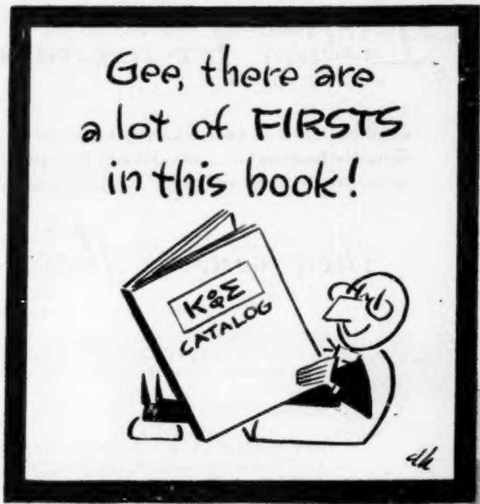
Zippy at 84

K&E have remained alert and alive, as is evidenced by their unending originality and inventiveness. They made America's first slide rules, as far back as 1891. And in both world wars, they did a big development job on optical equipment for our fighting men—on vital things such as periscopes, fire control instruments and height finders. The K&E catalog is full of "firsts"—some of them plenty recent, such as Wyteface* Measuring Tapes and Leroy† Lettering Equipment. No wonder it's the engineers' encyclopedia.



Factories within a Factory

K&E headquarters are a town within a town, many factories within a factory. In one area they're coating miles of papers and cloths. In another they're turning screws so tiny you feel like a hippopotamus if you try to pick one up. Here they're grinding optical lenses.



There they're putting graduations no bigger than a fly's kneecap on scales of some sort. Here they're doing fastidiously fine leather work. There they're reeling off steel measuring tapes by the mile.

But wherever you go you are aware of the age-old passion for precision and quality. And I'm not the least bit sorry that today I haven't sold you a single K&E product. I've just tried a little bit to sell you on the people at K&E—and to get you to believe that you can safely make K&E products trusted partners in your own creative work.

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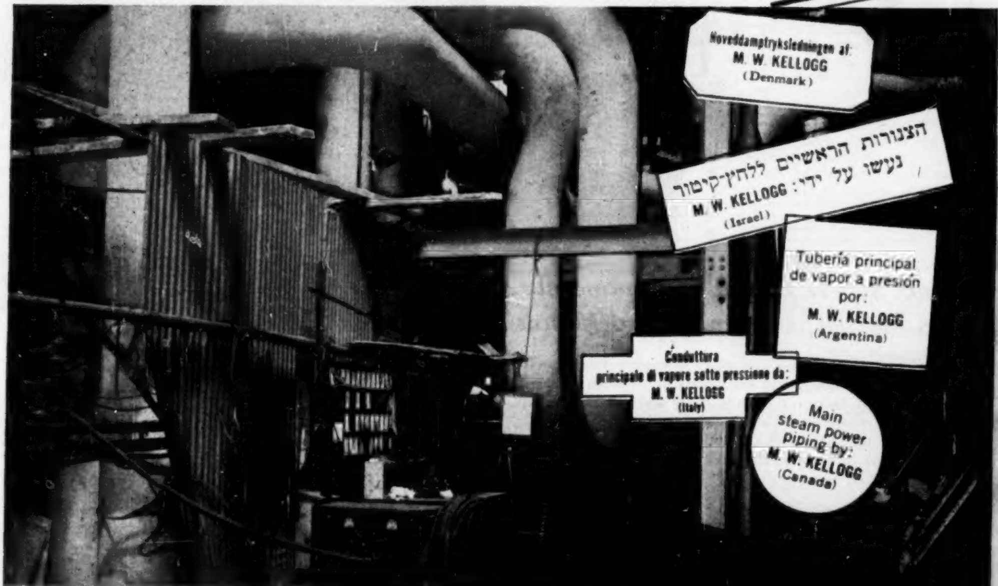

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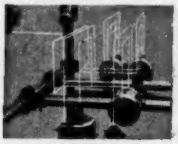

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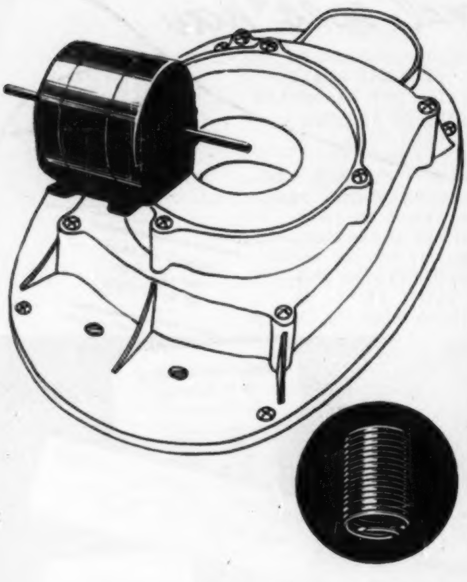

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MECHANICAL ENGINEERING

November, 1951 — CARD INDEX — Vol. 73, No. 11

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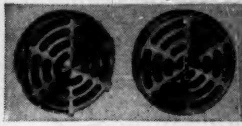

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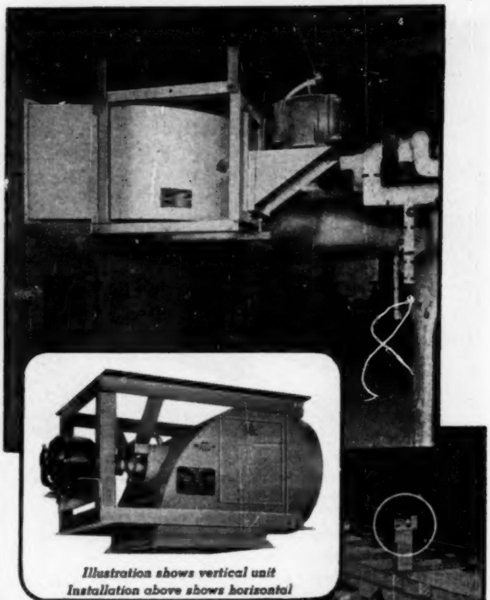

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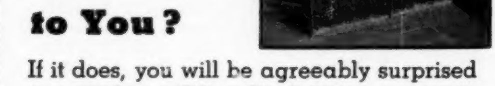

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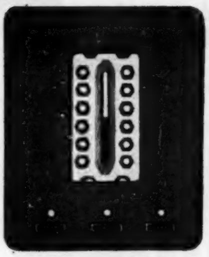
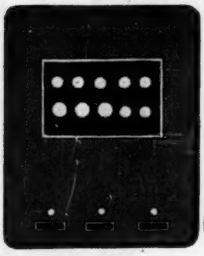
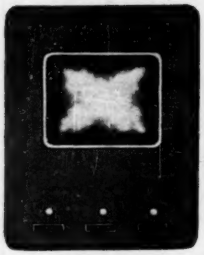


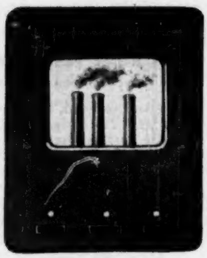
Boiler water level observation



Burner pilot observation



Boiler furnace combustion observation



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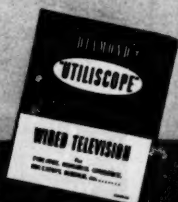

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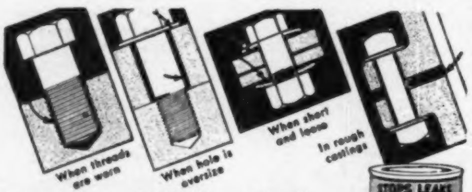

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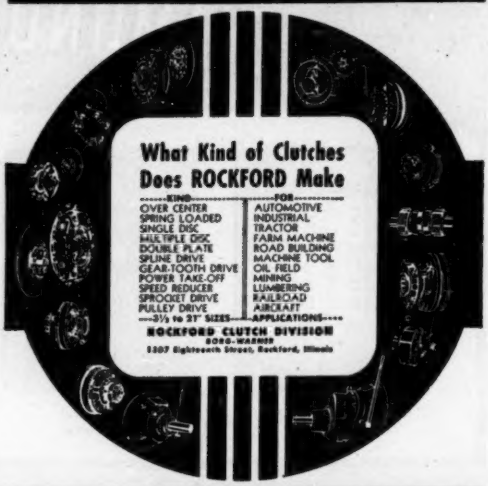

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Continued from Page 129

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See Advertisements on Preceding Pages

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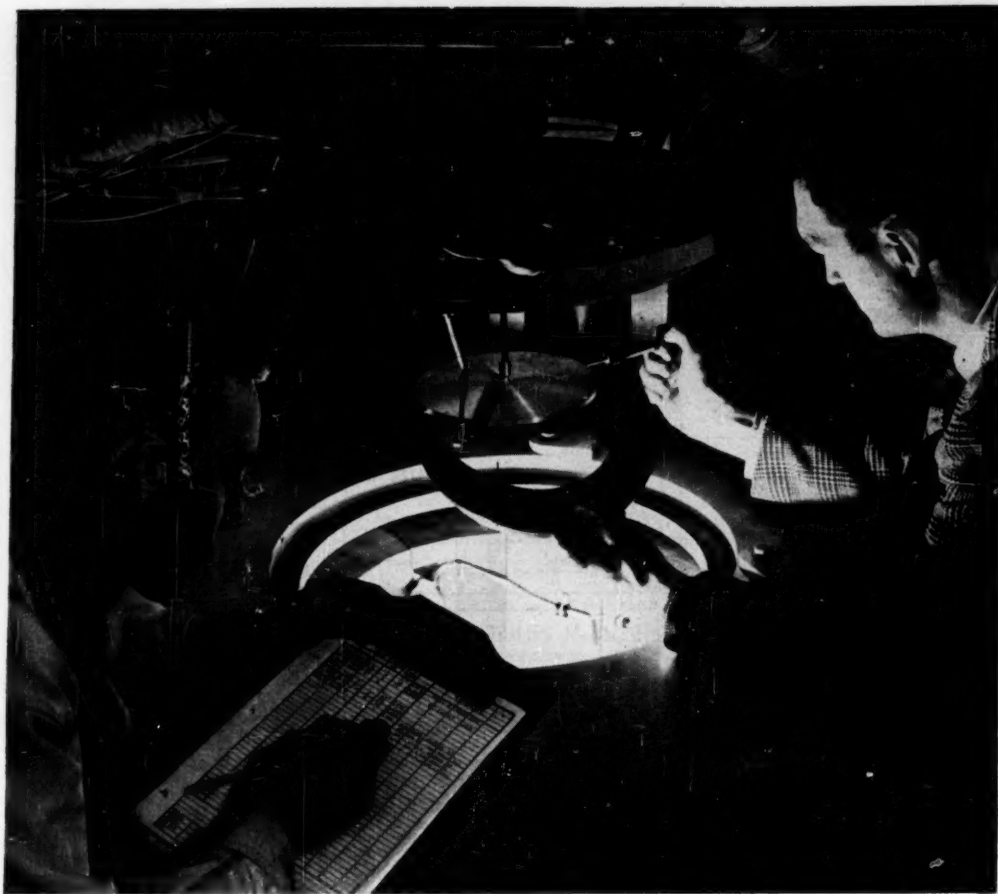

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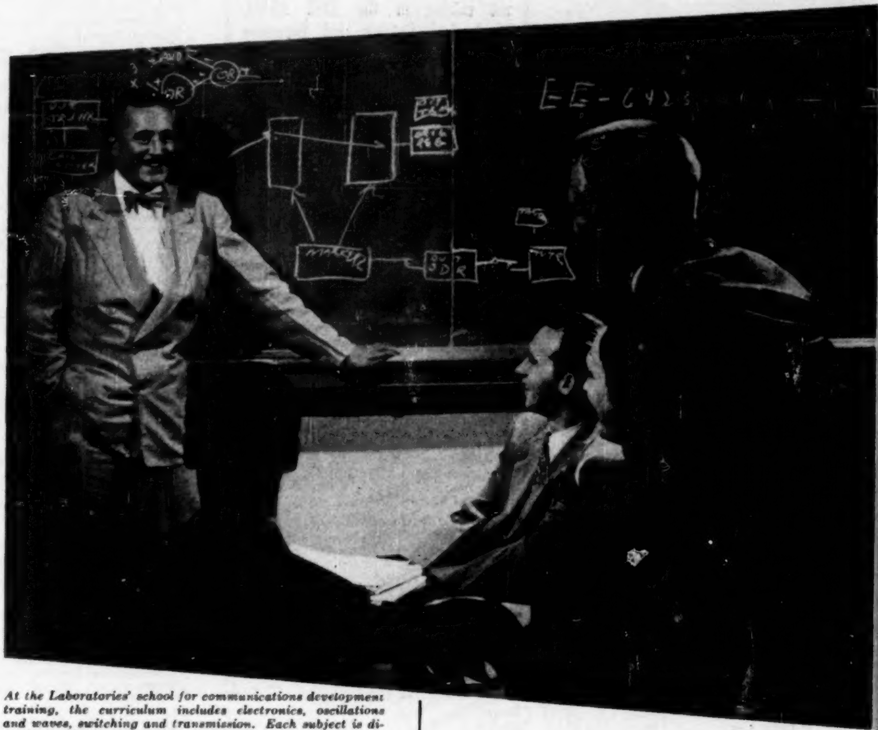

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Index To Advertisers

KEEP INFORMED—Pages 43-68 | **December, 1951** | **OPPORTUNITIES—(classified ads) Pages 125-131**

✱ The asterisk indicates that firm also has product catalog in the 1952 ASME Mechanical Catalog and Directory

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CONSULTING SERVICE . . . Page 132

Advertisers in previous 1951 issues but not in this issue

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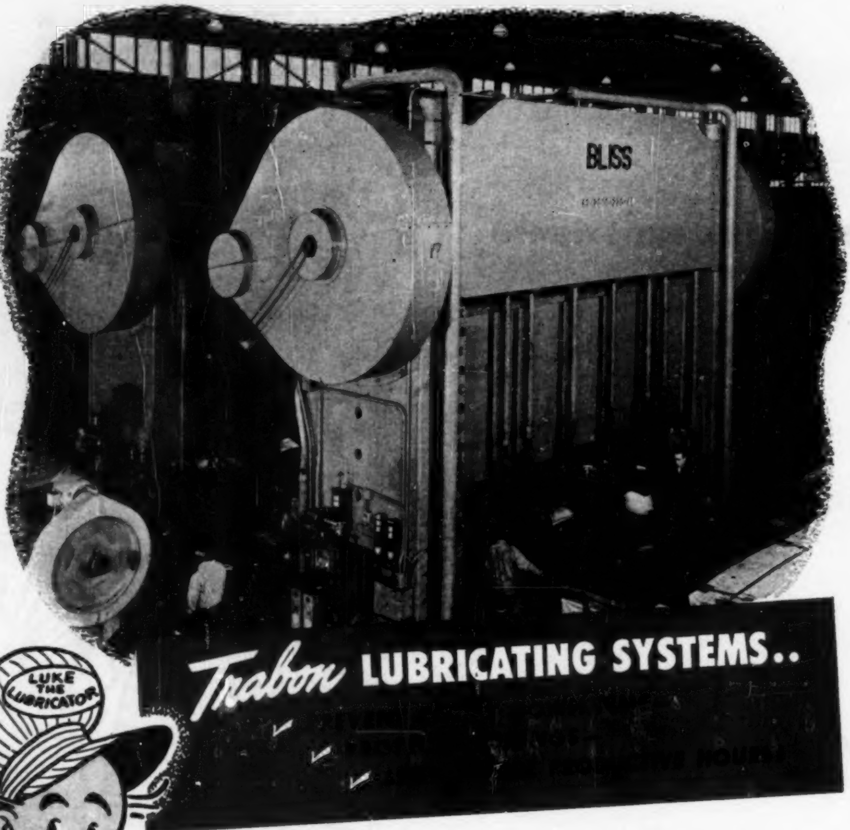

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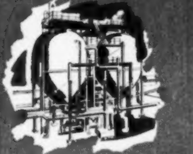
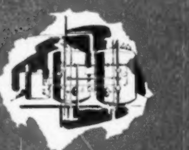
$85,500 a year!

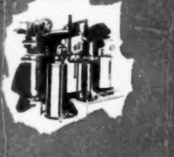
THESE BASIC PROCESSES, PLUS PERMUTIT SKILL, CAN SOLVE YOUR WATER CONDITIONING PROBLEMS



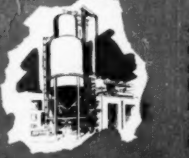
1. SLUDGE BLANKET HOT LIME SODA. Application of the sludge blanket to hot lime soda treatment reduces silica in boiler feed make-up, produces high quality steam.



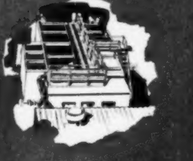
2. HOT ZEOLITE—PERMUTIT Q. Subsequent treatment of water from hot lime soda treatment yields effluent of zero hardness. Permutit Q, or styrene base mineral resistant to high temperatures, replaces second stage phosphate treatment.



3. SILICA REMOVAL PLUS DEMINERALIZATION. Demineralization by cold ion exchange processes produces water comparable to distilled water only at a fraction of the cost of distillation. Treatment by anion exchange resin, Permutit S, reduces silica to less than 0.2 ppm.



4. DEAERATING HEATER. The Permutit Deaerating Heater, utilizing exhaust or bled steam, prevents corrosion of feed lines, stage heaters, economizers, and boilers, by removing oxygen and free CO_2. Capacities from 12,000 to 1,400,000 pounds per hour are in service.



5. PRECIPITATOR. The Permutit Precipitator is used to lower alkalinity, reduce hardness, and help to remove turbidity, color, taste and odor. It can also be used to reduce silica.

REDUCES CORROSION RATE 90%
PREVENTS TUBERCULATION
CUTS TUBE REPLACEMENTS
LOWERS WATER CONSUMPTION

A chemical company in California installed a Permutit 5,000 gpm Vacuum Deaerator just over 2 years ago. Now here's what they have to say about it after exhaustive checking and comparison.

"The benefits occurring from water deaeration are difficult to calculate in their entirety, since so many of the advantages in small items such as clean water lines, better operation of valves, less frequent water line replacement and better water flow cannot be easily assessed. However, the major corrosion costs in this plant . . . have been determined and compared with the cost of deaeration . . ."

And the report goes on to cite actual net savings of $85,500 per year resulting from the installation of a Permutit Vacuum Deaerator.

Find out how Permutit can solve *your* water problems. Write to the Permutit Company, Dept. ME-12, 330 West 42nd Street, New York 18, N. Y., or the Permutit Company of Canada, Ltd., 6975 Jeanne Mance St., Montreal.

PERMUTIT®

WATER CONDITIONING HEADQUARTERS FOR OVER 38 YEARS

How to help a spindle carrier deliver precision

WITH six work spindles in its spindle carrier, the Greenlee automatic screw machine, shown below, can perform six cutting operations simultaneously. To maintain precision in each operation, all work spindles are mounted on Timken® tapered roller bearings.

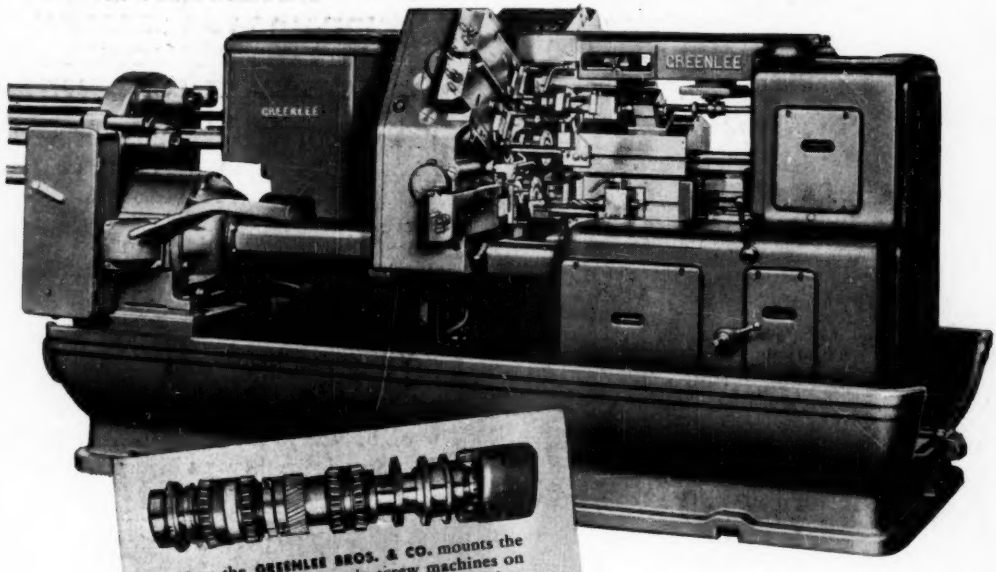
Timken bearings help eliminate spindle chatter. Work turns smoothly and accurately. Set-ups stay set. Greenlee Bros. & Co. also use Timken bearings in the gear box to provide a smooth flow of power through a wide range of speeds and feeds.

Because of tapered construction, Timken bearings take both radial and thrust loads in any combination, hold spindles in proper alignment. Line contact between rollers and races provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction.

Since Timken bearings are engineered for the job, precision manufactured and made of special analysis Timken fine alloy steels, they normally last the life of the machine.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in every machine tool you build or buy. Look for the trademark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How the GREENLEE BROS. & CO. mounts the spindles of its automatic screw machines on Timken bearings to insure lasting precision.

FINISHED TO CLOSER TOLERANCES

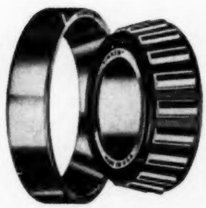
Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL AND THRUST → ← LOADS OR ANY COMBINATION